1997 Report to the Congress on

Ballistic

Missile

Defense

Note: The 1997 Report Was Drafted Prior To The Release Of The Results Of The Quadrennial Defense Review (QDR). Consequently, Changes Have Been Made In Certain Programs That Are Not Reflected In the Enclosed Report.

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Descriptors, Keywords: Strategy Theater Missile Defense TMD JTAMD Counterproliferation Threat Army Navy Air Force Marine Corps Doctrine Force Structure Patriot PAC-3 TMDI BMC4I Acquisition MEADS Architecture BPI Technology NATO UAV Directed Energy Boost SBIRS

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THE SECRETARY OF DEFENSE

WASHINGTON, DC 20301-1000

SEP 3 0 1997

Honorable Albert Gore, Jr.
President of the Senate
Washington, DC 20510

Dear Mr. President:

In accordance with section 224 of the National Defense Authorization Act for Fiscal Years 1990-1991, as amended, enclosed is the 1997 Annual Report to Congress on Ballistic Missile Defense (BMD) prepared by the Ballistic Missile Defense Organization (BMDO). The Report includes discussions of (1) Strategy and Objectives, (2) Theater Missile Defense, (3) National Missile Defense (NMD), (4) Technology Development Strategy and Programs, (5) Program Funding, (6) Anti-Ballistic Missile Treaty Compliance, (7) International Coordination and Consultation, and (8) Ballistic Missile Defense Countermeasures.

The Report has traditionally been tied to BMD programs reflected in the President's Budget. However, as a result of the Quadrennial Defense Review, changes have been made in certain programs that are not reflected in the enclosed report and other changes may be necessary. First, the Theater High Altitude Area Defense (THAAD) program will be restructured to allow time to correct problems in the flight test program and meet a First Unit Equipped of 2006. In addition, detailed engineering trade studies on THAAD/Navy Theater Wide (NTW) missile and component commonality will be conducted and reported to the USD(A&T) by February 28, 1998. The Navy and BMDO will budget for NTW risk reduction activities to support a Milestone II Decision in FY03. The Army and BMDO will continue the Medium Extended Air Defense System program through FY99 and plan for a Design and Development decision in early FY99. The Joint Theater Air and Missile Defense Organization and BMDO will produce a master plan by January 31, 1998, that outlines theater ballistic missile defense and cruise missile defense requirements. The BMDO and NMD Joint Program Office will continue NMD as a deployment readiness program leading to an integrated system test in FY99 and prepare for a decision on deployment as early as 2000, and to deploy an initial capability within three years after a decision to deploy is made. The Department of Defense will not budget for deployment ahead of a deployment decision. The Air Force will continue with the baseline Space Based Infrared System-Low program, and report related system studies and design trades to identify non-NMD mission utility to the USD(A&T) by December 31, 1998.

Sincerely,

William S. Cohen

Enclosure:
As stated

Table Of Contents

Chapter 3
National Missile Defense (NMD)

Chapter 4
Supporting Technology Development Strategy And Programs

Chapter 5
Program Funding

Chapter 6
ABM Treaty Compliance

Chapter 7
International Coordination And Consultation

Chapter 8
Ballistic Missile Defense Countermeasures

Appendix A
Annual Report To Congress On Ballistic Missile Defense

Appendix B
Current Program, Projects, And Activities – Narrative Description And Status

Appendix C
Acronyms

List Of Figures

List Of Tables

Chapter 1

Strategy And Objectives

Chapter 1
Strategy And Objectives

1.1 Introduction

This report responds to the annual reporting requirements specified by section 224 of the National Defense Authorization Act for Fiscal Years 1990 and 1991 (Public Law 101-189), as amended by successive legislation up to and including section 244 of the National Defense Authorization Act for Fiscal Year 1997. A complete inventory of relevant legislation outlining reporting requirements is summarized in Appendix A.

The report describes the overall Ballistic Missile Defense (BMD) strategy and describes the distinct programs and projects included in the overall effort, addresses international participation in BMD research, discusses the certification status of compliance of planned development and testing programs with existing arms control agreements, and provides details of current and planned funding for BMD. Chapters 2, 3, and 4 describe the program strategy, architecture, and planning for Theater Missile Defense (TMD), National Missile Defense (NMD), and Advanced Technology programs, respectively; Chapter 5 describes the funding requirements of the BMD Program; Chapter 6 addresses ABM Treaty compliance; Chapter 7 addresses the status of international consultations; and Chapter 8 addresses efforts regarding countermeasures, as they relate to the current BMD program.

The reporting requirements related to the earlier Strategic Defense Initiative (SDI) program directed at a phased deployment of defenses to counter a massive Soviet attack have been carefully considered in developing the report, but are not specifically addressed since they are no longer required as per the FY 1997 National Defense Authorization Act.

As a result, three of the original FY 1990-91 National Defense Authorization Act reporting requirements relating to the earlier SDI mission were deleted in their entirety, while two others deleted language related specifically to that mission. Figure 1-1 provides a summary of the subsequent reordering of reporting requirements from their original FY 1990-91 designation to their FY 1997 redesignation as directed by the National Defense Authorization Act of FY 1997. Each current reporting requirement is detailed in Appendix A. Table 1-1 also identifies the chapter(s) in which each requirement is addressed.

In addition, the Congress introduced a new Program Accountability Report requirement, specified in Section 234(e)(1) of the National Defense Authorization Act for Fiscal Year 1996, which requires the Secretary of Defense to "describe the technical milestones, the schedule, and the cost of each phase of development and acquisition...for each core and follow-on theater missile defense program." Section (e)(2) requires the report to include a description of variances in the technical milestones, program schedule milestones, and costs compared to both (1) the report submitted the previous year and (2) the report submitted the first (initial) year. This report requirement is addressed within Chapter 2 as part of the detailed discussion of the TMD Major Defense Acquisition Programs.

Table 1-1. Reporting Requirement Change Summary		
Original Requirement*	**Current Requirement****	**Chapter Requirement Addressed In**
224(b)(1)	244(b)(1)	2, 3, & 4
224(b)(2)	244(b)(2)	2, 3, & 4
224(b)(3)	Original Requirement Deleted	N/A
224(b)(4)	Original Requirement Deleted	N/A
224(b)(5)	244(b)(3)	7
224(b)(6)	244(b)(4)	6
224(b)(7)	244(b)(5) + Language Deletions	8
224(b)(8)	244(b)(6)	5
224(b)(9)	244(b)(7) + Language Deletions	2, 3, 4, & 8
224(b)(10)	Original Requirement Deleted	N/A

*** As Designated By Section 224 Of The National Defense Authorization Act For Fiscal Years 1990 And 1991**

**** As Redesignated By Section 244 Of The National Defense Authorization Act For Fiscal Year 1997**

1.2 Ballistic Missile Defense (BMD) Program Priorities

Ballistic Missile Defense is an essential element of the U.S. National Military Strategy of flexible and selective engagement and for the achievement of that strategy's three components: peacetime engagement, deterrence and conflict prevention, and fighting and winning our Nation's wars.

Ballistic Missile Defense is an indispensable part of the peacetime engagement of our Armed Forces, providing opportunities for military-to-military contacts and security assistance programs which demonstrate commitment to our friends and allies, improving collective military capabilities, defending democratic ideals, and otherwise enhancing national security and regional stability.

Ballistic Missile Defense also contributes to the second component of U.S. National Military Strategy: deterrence and conflict prevention. The presence of BMD capabilities in regions where U.S. and allied interests are threatened, most significantly in Northeast Asia and the Middle East, will help deter potential aggressors from employing ballistic missiles by increasing the probability that such use would not be successful.

However, in the event that deterrence fails, the presence of defenses against states employing ballistic missiles armed with conventional, nuclear, biological, or chemical warheads helps ensure the third component of U.S. National Military Strategy--that U.S. Armed Forces be able to effectively fight and prevail in any armed conflict. In that event, ballistic missile defenses would directly protect United States. and allied armed forces and other valued assets from such an attack thus allowing the Commanders-in-Chief (CINCs) and warfighters to execute their mission more efficiently and effectively.

To ensure these capabilities, the Department focuses the BMD Program on three distinct priorities: (1) TMD, to address the short-range, widely dispersed theater ballistic threat which is here and now; (2) NMD, to position the United States to defend against a limited ballistic missile threat; and (3) Advanced Technology, which supports both TMD and NMD, to continue to advance our capabilities to counter future and possibly more complex threats.

Since early-1996, following the Defense Department's BMD Program Review, BMDO has been executing a TMD program plan which includes:

- Improving the capability of lower-tier systems, including both land- and sea-based defenses to protect critical assets and U.S. and friendly forces in inland and littoral (coastal) areas;

- Proceeding to add, albeit at a slower pace than previously envisioned, upper-tier (wide area) defenses and defenses against longer-range theater missiles, including Boost Phase Intercept (BPI) systems with the Air Force's Airborne Laser (ABL) Program as the primary BPI solution, as that threat emerges; and

- Continuing the development of upgraded Battle Management/Command, Control, Communications, Computers, and Intelligence (BM/C^4I) to improve early warning and dissemination, communications interoperability, and command and control centers for the "family" of TMD systems.

These added capabilities also provide improved lethality and probability of kill through the use of interceptors which employ advanced concepts such as directed energy hit-to-kill or improved guidance techniques combined with fragmentation warheads. Further, the tiered approach provides engagement opportunities throughout all phases of the Theater Ballistic Missile (TBM) flight: at both lower-altitudes and shorter-ranges (lower-tier intercepts within the atmosphere); at higher-altitudes and longer-ranges (upper-tier, exoatmospheric and high endoatmospheric intercepts); and during the boost phase (at various ranges) while the missile is over the aggressor's territory, for added effectiveness--a layered defensive capability. Finally, other advanced concepts for TMD will be demonstrated and/or explored.

The NMD program, the second priority of BMD, is structured as a "deployment readiness" program that is implemented by a "3+3" strategy. During the next three years the elements of an initial NMD system will be developed to allow an Integrated System Test (IST) in FY 1999. From that point, if a decision is made to do so, a NMD system capable of defending the 50 states against

a limited threat could be deployed to achieve an Initial Operational Capability (IOC) within an additional three years. If the threat does not warrant a deployment decision after the FY 1999 test, additional development and testing will be accomplished, leading to a steadily increasing technical capability always positioned to allow fielding within a three year window. This strategy has the inherent advantage of positioning the United States to be able to defend against a relatively sudden and unexpected threat from a rogue nation without sacrificing the ability to defend against more sophisticated limited threats should that need arise.

The third BMD program priority is the Advanced Technology program to provide technology options for improvements to planned and deployed defenses. The program will invest in high leverage technologies that yield improved capabilities for TMD and NMD interceptors and sensors. Particular components that would be developed for each mission would be distinct and separate, but the technology is common to both missions. This investment will provide block upgrades to baseline systems that were developed, demonstrations to reduce risk and provide a more speedy path for technology insertion, and will prepare the United States for evolving, proliferating threats, which may include advanced countermeasures and submunitions. Further, the Advanced Technology program will explore and demonstrate alternate system approaches (i.e., Space Based Laser) that can provide major increases in TMD and NMD capability against the current and evolving threat.

1.3 Cooperation with Allies and Friends

As part of broader efforts to enhance the security of U.S. and allied forces against missile strikes and to complement counterproliferation strategy, the United States continues to explore opportunities for cooperation with its allies and friends in the area of TMD. The international community increasingly recognizes the existence and growth of the threat of missile attack and, as a consequence, commitments to TMD study and development efforts by U.S. allies have been increasing. Significant international participation in the BMD program will help achieve the U.S. goal of developing and deploying interoperable missile defense systems at reduced cost.

1.4 Anti-Ballistic Missile Treaty

The United States has continued to pursue agreements to clarify the 1972 Anti-Ballistic Missile (ABM) Treaty to preserve its viability in the context of the changed technological and political circumstances of the 1990's. In October 1996, the ABM Treaty's Standing Consultative Commission (SCC), with the participation of the United States, Russia, Belarus, Kazakhstan, and Ukraine, completed a draft of the so-called "Part 1" agreements. These relate to the multilateral succession to the ABM Treaty, demarcation of lower-velocity TMD systems, and confidence building measures concerning TMD systems. The "Part 1" demarcation agreement would make clear that TMD systems with interceptor missiles having velocities of 3 km/sec or less are compliant with the ABM Treaty, provided they are not tested against a ballistic missile target having a velocity or range greater than 5 km/sec or 3,500 km, respectively. Based on a ministerial-level agreement with Russia, the United States expected that the "Part 1" agreements would be signed by deputy foreign ministers at the end of October. Discussions also began in the SCC in October on a "Part 2" agreement on demarcation of higher-velocity TMD systems. However, late in October, the

Russians proposed changes to the documents that were inconsistent with that agreement between foreign ministers and unacceptable to the United States. Consequently, the documents were not signed.

Subsequent discussions at the political level and in a February-March session of the SCC failed to resolve outstanding issues. The deadlock, however, was broken by Presidents Clinton and Yeltsin at the March 20-21 Helsinki Summit. In a Joint Statement at the conclusion of their meetings, the Presidents announced agreement on the elements of a "Part 2" demarcation agreement. These elements are; (1) the velocity of TMD ballistic target missiles will not exceed 5/km/sec; (2) the range of TMD ballistic missiles will not exceed 3,500 km; (3) the sides will not develop, test, or deploy spaced-based TMD interceptors or components based on alternative technologies that could substitute for spaced-based TMD interceptors; and (4) the sides will exchange detailed information annually on TMD plans and programs. They also reaffirmed the importance of preserving the ABM Treaty and enhancing its viability, and declared that they had instructed their experts to "complete a demarcation agreement on higher-velocity TMD systems as soon as possible." SCC #55 convened on May 14, 1997.

The Administration continues to believe it is desirable to conclude agreements on demarcation that would record a clear understanding on the compliance of TMD systems and preclude disputes or ambiguities concerning current and future TMD systems. In any event, however, the United States has made clear that U.S. TMD programs must and will go forward, and that each side will continue to make its own compliance determinations. To date, the Department of Defense (DoD) has determined that all of the core U.S. TMD programs, including Theater High Altitude Area Defense (THAAD) and Navy Theater Wide (NTW), are compliant as currently planned.

1.5 Conclusion

The U.S. Ballistic Missile Defense Program is a balanced program directed toward developing TMD, a critical component of a U.S. National Security Strategy that focuses on regional crises and proliferation; developing and testing an evolving NMD capability and maintaining a readiness to deploy such a capability when needed; and exploring advanced technologies essential for defenses against future threats. The remaining chapters in this report discuss program objectives in greater detail, describe the programs and projects being pursued to achieve these objectives, and summarize the current status and plans for each program.

Chapter 2

Theater Missile Defense

Chapter 2
Theater Missile Defense (TMD)

2.1 Mission and Scope

The mission of Theater Missile Defense (TMD), as defined in the TMD Mission Need Statement (MNS) is "to protect U.S. forces, U.S. allies, and other important countries, including areas of vital interest to the U.S., from theater missile attacks." The TMD mission includes protection of population centers, fixed civilian and military assets, and mobile military units.

The MNS also provides a basis for defining the scope of the program in terms of areas of TMD and the threats to be countered. It identifies four elements of TMD, frequently called "pillars": Attack Operations (AO); Active Defense (AD); Passive Defense (PD); and Battle Management/ Command, Control, Communications, Computers, and Intelligence (BM/C^4I). The scope of the BMDO TMD program is to focus on AD and the associated BM/C^4I. The MNS defines theater missiles as "ballistic missiles, cruise missiles, and air-to-surface guided missiles whose target is within a theater or which is capable of attacking targets in a theater."

The Department realizes that an imbalance in activity exists between Ballistic Missile Defense (BMD) and Cruise Missile Defense (CMD). Therefore, the Department has established a new management process to coordinate its requirements activities with the acquisition activities of the Services and the BMDO to develop an integrated Theater Air and Missile Defense (TAMD) strategy. A key to this management process is the establishment of the Joint Theater Air and Missile Defense Organization (JTAMDO). In order to integrate effectively and efficiently both the requirements definition and acquisition of TAMD, JTAMDO and BMDO will work together in developing a TAMD Master Plan for approval by the Joint Requirements Oversight Council (JROC) and Service and BMD Acquisition Executives.

2.1.1 Joint Theater Air and Missile Defense (JTAMD)

BMDO and JTAMDO have a shared responsibility to provide the Joint Force Commanders with an improved capability to defend against air and missile threats. The JTAMDO will define the required system interoperabilities and operational architectures and validate mission capabilities in coordination with the warfighting CINCs and Military Services. The JTAMDO effort integrates warfighter priorities into the Requirements Section of the TAMD Master Plan. BMDO assumes the role of Integration System Architect for theater air, cruise, and ballistic missile defenses. Jointly with JTAMDO and the Services, BMDO will work to translate the JTAMDO-developed operational architecture into a systems architecture, perform systems engineering at the architecture level, plan and ensure integrated testing of defense architectures, and lead program acquisition activities. BMDO will also work closely with Service and joint program offices to develop the Acquisition Section of the TAMD Master Plan.

BMDO expects its program plans to evolve over the next year as the results of on-going studies become available. While JTAMDO is responsible for developing centralized planning for TAMD in collaboration with the CINCs, Joint Staff and Services, the Defense and Component Acquisition Executives, requirements developers, program manager and resource allocation officials will execute the program in a decentralized manner.

JTAMDO and BMDO will work closely to fulfill their responsibilities by using an Integrated Product Team (IPT) approach to produce an effective Family of Systems (FoS) architecture, ensure its proper test and evaluation, and to integrate the FoS, which will provide an effective, wide-area missile defense against emerging threats. Toward this end, the Deputy Director, JTAMDO, and the Deputy for Theater Air and Missile Defense, BMDO, are cochairing an Integration IPT (IIPT) to oversee coordination of TAMD architecture and acquisition activities.

Through this process, which includes representatives from BMDO, JTAMDO, the Service Acquisition and Requirements communities, the CINCs, Joint Staff, the Office of the Secretary of Defense (OSD), the Intelligence community, and Defense Advanced Research Projects Agency (DARPA), BMDO and JTAMDO are developing a Master Plan building upon the existing TMD MNS, Joint Doctrine, existing Service programs, the TMD Active Defense Framework, and TMD Acquisition Strategy. The basic elements of these are discussed below.

2.2 Threat and Counterproliferation

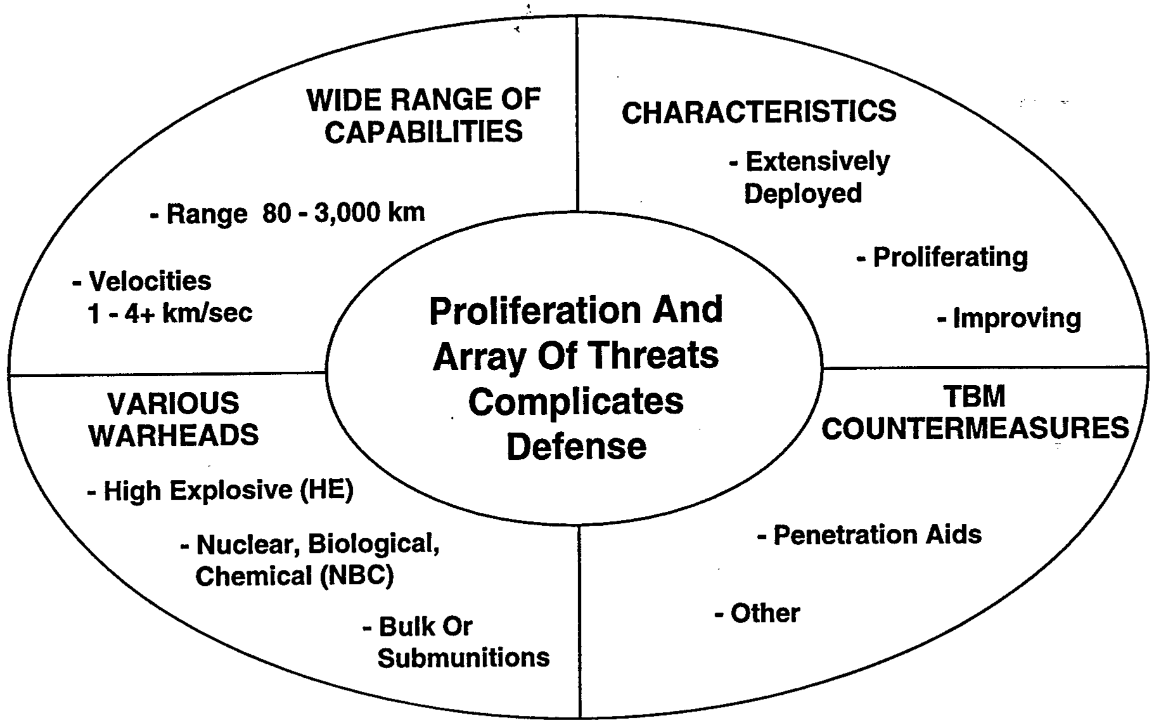
2.2.1 Threat

The continuing proliferation of ballistic and cruise missile systems is driving the development efforts of U.S. TMD planners. The proliferation of short-range ballistic missiles in the world today poses a direct, immediate threat to many of our allies and to some U.S. forces deployed abroad in defense of our national interests. The current threat includes tens of countries armed with missiles, hundreds of missile launchers, and thousands of missiles with ranges up to 3,000 kilometers. While the threat posed by these systems is largely regional, the trend is clearly in the direction of systems of increasing range, lethality, accuracy, and sophistication.

Because of their availability, theater missiles are proliferating throughout the world. A wide range of capabilities are available depending upon the investment a particular nation is willing to make and the technologies used. Adding to the complexity of the threat is the wide variety of warheads including high explosives, chemical agents, biological agents in unitary and submunition payloads, and nuclear weapons. The evolving threat may also employ countermeasures to reduce the effectiveness of TMD systems. Thus, the array of TBM threats and their proliferation significantly complicates the TMD mission. Figure 2-1 summarizes the current Theater Ballistic Missile (TBM) threat.

The proliferation of precision guidance, potential low observable technologies, and relatively inexpensive Land Attack Cruise Missiles (LACMs) has given adversaries an alternative for expanding their air deliverable threats. Such a threat could materialize via several paths, including: (a) indigenous development using components procured on the world market; (b) modification of existing unmanned air vehicles or antiship cruise missiles; or (c) the direct procurement of complete missile systems. Adding to BMDO concern is recognition that cruise missiles could be employed with low observable features and could be seen by our enemies as an attractive delivery mechanism for warheads of mass destruction. Although our intelligence has not yet identified an existing threat, BMDO is very concerned that a threat could emerge quickly with few early indications.

Figure 2-1. Summary Of The Theater Ballistic Missile Threat



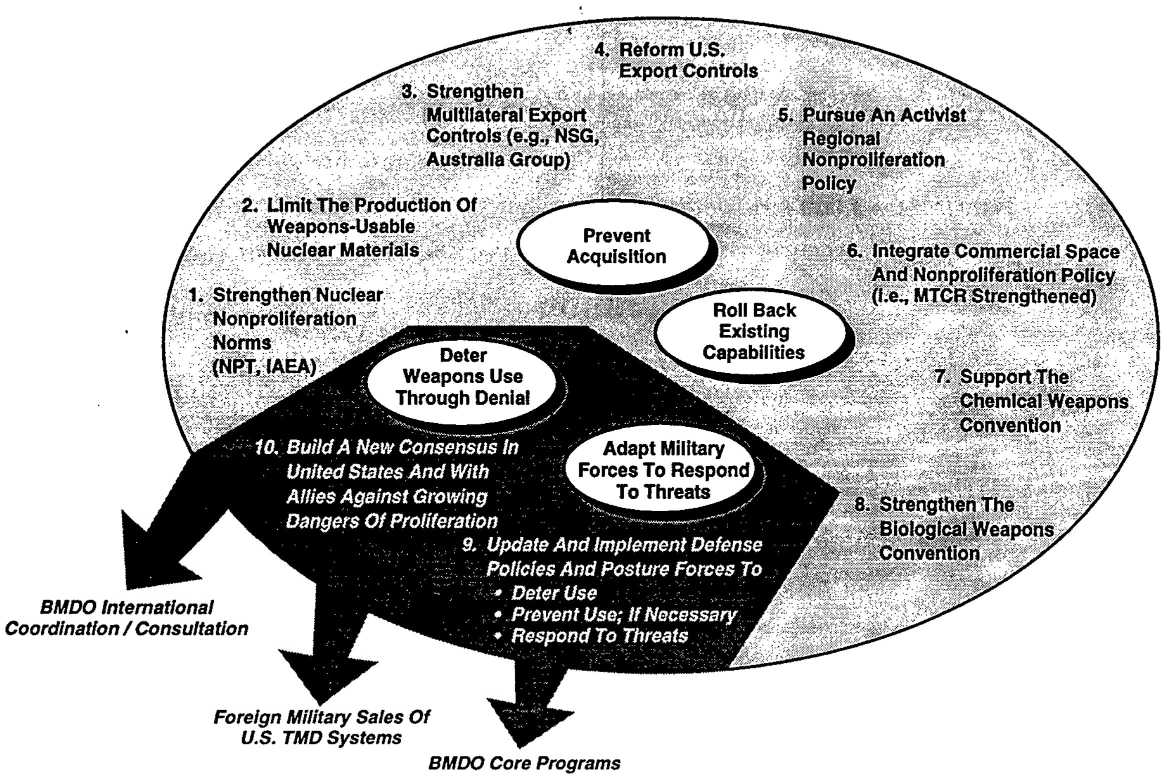
2.2.2 *Counterproliferation*

In a 1993 foreign policy speech to the United Nations, President Clinton stated that the proliferation of Weapons of Mass Destruction (WMD) and their delivery systems was a significant danger to U.S. national security and that controlling this proliferation was "one of the most urgent priorities." In response, Congress directed the Department of Defense (DoD) to lead an interagency study of Nonproliferation (NP) and Counterproliferation (CP) activities. As part of ongoing direction from Congress, DoD chairs an interagency Counterproliferation Review Committee (CPRC) and reports to Congress annually recommendations pertinent to modifications in programs required to address shortfalls in existing and programmed capabilities to counter the proliferation of WMD. This requirement has been extended by the FY 1997 Congressional Authorization Conference Report through FY 2000.

Figure 2-2 presents the principal elements of the U.S. strategy to stem proliferation. The highlighted areas are BMDO's contributions to this effort.

FY 1996 was a year of intense program review and budgetary scrutiny by both the Chairman of the Joint Chiefs of Staff (CJCS) and OSD. Specifically in FY 1996, the OASD(PA&E) conducted a Front End Assessment (FEA) of the CP Program Objectives Memorandum (POM). BMDO participated in the FEA providing scenarios, models, and simulation tools and assessments to demonstrate the relative benefit among active defense, attack operations, and passive defense capability. An important result from the FEA was that active defense is critical, especially early in a crisis. Attack Operations was also assessed as complementary to active defense, sharing cueing systems

Figure 2-2. Counterproliferation And The BMDO Contribution



and working to thin the threat later in a crisis to reduce the required active defense inventory and reactive stress loads.

Concurrent with the FEA, the FY 1996 CP Joint Warfare Capabilities Assessment (JWCA) surveyed all CINCs and returned an integrated and updated list of CP-related priorities and identified shortfalls (Figure 2-3) in capabilities to conduct warfare in a WMD threat environment. The Assistant to the Secretary of Defense for Nuclear, Chemical and Biological Programs (ATSD (NCB)), who manages the CP program for DoD, takes these CINC recommendations and establishes prioritized Areas for Capability Enhancement (ACE). Theater Ballistic Missile Active Defense was assessed #4 and #5 out of the "top 15" on the ACE lists. These two prioritized lists help focus ATSD(NCB) and the CPRC in supporting budgetary and programmatic priority.

BMDO was also successful in obtaining greater CPRC attention to U.S. programs of international cooperation. These international programs are to incorporate regional-specific strategies with associated effective interoperability solutions for combined warfare. These efforts, such as the NATO's Recognizable Air Picture, will serve as a valuable template for U.S. command and control requirements for TAMD.

BMDO will continue to maintain liaison with the ATSD(NCB) and other agencies with CP-related programs. As part of an ongoing investigation into the synergy between attack operations

Figure 2-3. Counterproliferation Priorities And Shortfalls

CINC Priorities	POM Improvements	Key Shortfalls
1. CP Intelligence Cycle		1. Not Assessed
2. Conventional Response With Minimal Collateral Effects	2. Improve Collateral Effects, Prediction, And Targeting Tools, Weapons Improvements	2. No Procurement Tails For ACTD Products
3. Special Operations Forces Response And Intelligence Collection / Analysis Targeting Covert / Paramilitary / Terrorist Threat	3. Improve Nuclear, Biological, And Chemical (NBC) Detection, Weapon Disablement, And Consequence Management	3. Unfunded Special Operations Command Capabilities, Chemical Threat Consequence Management Planning Exercise, Counterterrorism NBC Detection And Warning
4. Battlefield Nuclear, Biological, And Chemical Detection And Warning	4. Significant Modernization: New Chemical Dectectors, Detection On The Move, First Generation Biological Detectors	4. Biological Detection, Warning And Reporting; Insufficient Inventory Of All Items
5. TMD With Minimum Collateral Effects	5. 90% Intercept At Air Bases And Ports	5. Insufficient Inventory Of Interceptors
6. Defeat Underground Targets	6. Tunnel Defeat And Denial Technologies Explored	6. No Deep Tunnel Capability: No Procurement Tails For ACTD Products
7. Target Plan / Analysis Including Collateral Effects Prediction And Post Strike Assessment	7. Improved Planning Tools, Bomb Damage Assessment, Data Fusion And Munitions Effectiveness Assessment	7. No Procurement Tails For ACTD Products
8. Individual Protection	8. JSList Provides Improved Protection And Wearability	8. Insufficient Quantities; Protection Of Civilian Port Workers
9. Proliferation Pathway Analysis	9. Proliferation Path Analysis Tool	9. Shortfall Met
10. CMD / Aircraft Defense With Minimum Collateral Effects		10. Not Assessed
11. Collective Protection	11. Medical Facility Collective Protection	11. Sustained Operations On Air Base
12. Mobile Target Defeat	12. 20%-50% Defeat Capability	12. Not Assessed
13. Offensive Information Warfare		13. Not Assessed
14. CP Consequences Logistics Capability		14. Not Assessed
15. Decontamination	15. Tech Base Studies Of Nonaqueous And Large Area Decontamination	15. Sustained Operations On Air Base
16. NBC Medical Treatments		16. Not Assessed

and active defense, the ATSD(NCB/CP), the principal deputy for CP, has requested that the WMD-related target base studies currently underway in OSD, the Strike JWCA, and the Services be more closely integrated with BMDO's attack operations and active defense assessments.

2.3 Doctrine, Tactics, and Training

The future success of theater missile defenses will depend almost as much on doctrine, tactics, and training as on new weapon systems and force structure. To speak of TMD as a purely weapons driven program is to miss the magnitude of the problems facing the warfighter. TMD assets are developed, acquired, and tested by the Services with embedded interoperability, survivability, security, and sustainability for withstanding robust defense suppression threats in joint operational areas. Issues such as decentralized versus centralized control of TMD assets, the integration of TMD systems with an existing air defense force structure, and the ability to preposition or deploy TMD forces into the theater will be dominant themes in the coming years.

2.3.1 Joint Doctrine

The Department of Defense Joint Publication 3-01.5, *Doctrine for Joint Theater Missile Defense*, provides current TMD guidance on missions, command relationships, and responsibilities for combatant commanders and other joint force commanders, and prescribes doctrine for joint operations and training. The Joint Chiefs of Staff (JCS) is currently staffing Joint Publication 3-01, *Doctrine for Countering Air and Missile Threats,* as replacement doctrine guidance for Joint Publication 3-01.5. When completed, this publication will establish guidance for theater and joint force commanders to conceptualize, plan, and coordinate joint operations to counter aircraft, missile, and other threats within the air environment. It is further envisioned that JP 3-01 will be supported by two sets of Joint Tactics, Techniques, and Procedures yet to be developed: one for offensive operations and another for defense operations.

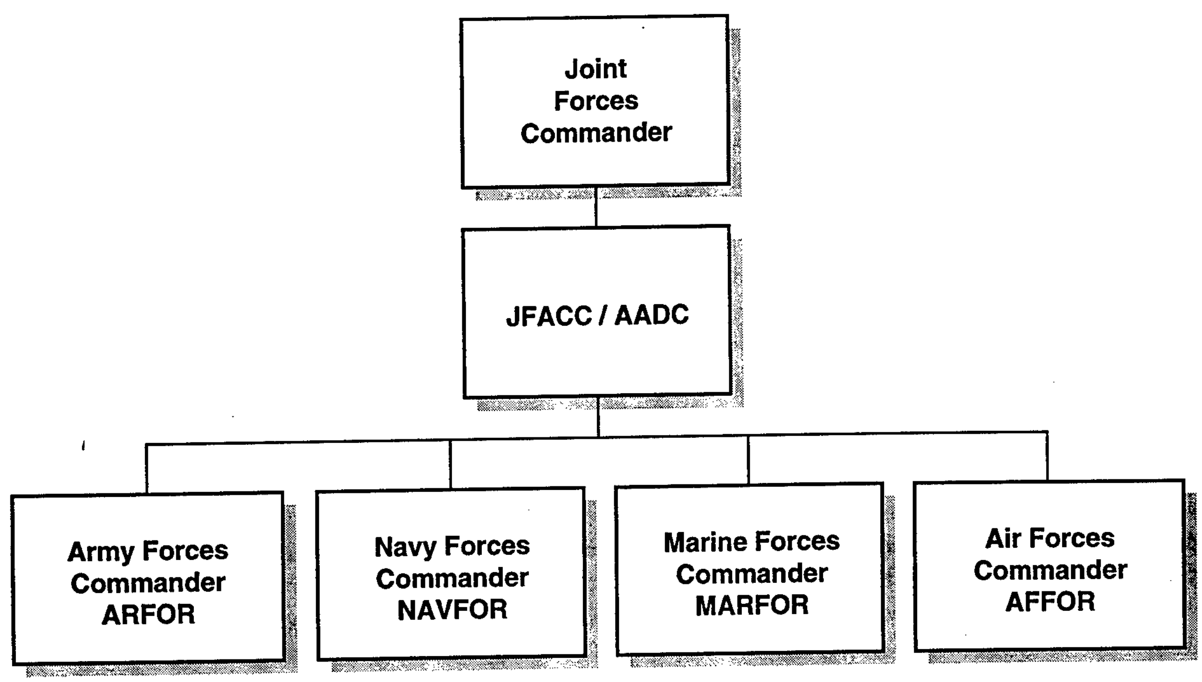
2.3.1.1 Joint Force Structure

Within the theater, the Army, Navy, Air Force, and Marines may be organized under their Service component commanders and report to the Joint Forces Commander (JFC). Alternatively, the forces may be organized under a Joint Forces Air Component Commander (JFACC), Joint Forces Land Component Commander (JFLCC), or Joint Forces Maritime Component Commander (JFMCC). In this case, for example, Marine forces may transition from the JFMCC to the JFLCC as they go ashore, and each Joint Force commander may have multiple Service units under its operational control.

Two principal players in the Joint Theater Missile Defense (JTMD) area are the JFACC and the Area Air Defense Commander (AADC). The JFC will normally assign overall responsibility for air defense to the AADC. Authority to integrate theater/Joint Operations Area-wide air defense forces and operations will be delegated to the JFACC/AADC. Air defense operations should be coordinated with other tactical operations, both on and over land and sea. Representation from all components involved should be provided, as appropriate, to the AADC headquarters. The JFC will normally assign responsibility for the planning and execution of JTMD attack operations or Offensive Counter-air Operations (OCA) outside the other component commander's areas of operations to the JFACC. Because of the need for the JFACC to maintain theater-wide visibility of JTMD attack operations and the integrated relationship between attack operations/OCA, active defense, and the other operational elements of JTMD, the JFC normally assigns the responsibilities of the AADC to the JFACC. Figure 2-4 shows a joint force structure.

The joint nature of TMD operations may be most evident in the missile detection and warning structure established to support the theater JFC and component commanders. BMDO is active in several systems, described below, that directly support the joint force structure.

Figure 2-4. Joint Force Structure



Logistics, force deployment, and asset prepositioning will continue to be major concerns to theater commanders. The United States has moved from a force structure that was forward based to one that is largely based in the continental United States (CONUS). These CONUS-based assets must be deployed to regional theaters, as needed, to support the operational commanders. The need to mobilize and transport large inventories of personnel and equipment will stress air, land, and sea lift capabilities. Prioritizing assets for transport in the crucial first days of an overseas campaign will present a critical challenge. During the Gulf War, U.S. TMD forces were already in place, trained, and integrated into the joint force structure when the first enemy missiles were launched. The United States and its allies may enter future campaigns under less favorable circumstances. In fact, an enemy may choose to expend the majority of its theater missiles well before U.S. and allied TMD assets can arrive on the scene. The major problems, then, are how much force structure should be prepositioned in anticipation of an actual deployment decision, and where and when should TMD forces be programmed into an already overburdened air and sea lift system.

The following paragraphs present the Army, Navy, Air Force and Marine Corps doctrine, tactics, training, and force structure overviews for TMD operations.

2.3.2 Army Doctrine

The role of Army TMD is to support the U.S. National Military Strategy of defense against theater missile attacks by protecting ground forces, conducting precision strikes, and dominating the

maneuver battlefield. In fulfilling this role, virtually all operational scenarios envision the deployment of Army TMD forces as part of joint or combined forces. Army TMD provides theater CINCs with the ability to protect population centers, logistics assets, command and control centers, and other land based forces and critical assets, whether they are ground maneuver units, air bases, or naval port facilities, from the theater missile threat. The Army does this in two ways: first, by destroying enemy missiles (AD), and second, by conducting precision offensive counter strikes (AO). Army TMD helps CINCs protect, project, and sustain friendly forces by defending Air and Sea Ports Of Debarkation and Lines Of Communication against theater missile interdiction, and by protecting maneuver forces from being destroyed or contained in rear areas.

To establish and maintain an effective TMD capability against all theater missiles, the Army implements acquisition, intra-Service integration, and joint and combined interoperability warfare planning for Army TMD systems. The Army also identifies Army TMD requirements, and performs combat development, materiel development, and force development functions (doctrine, training, tactics, and force structure). This ensures resources are programmed to acquire weapon systems and to support unit activation, deployment, and sustainment after fielding.

Locating and destroying threat missile systems on the ground and in the air with AO and AD systems, preventing and minimizing the damage caused by theater missiles through PD, and integrating those capabilities with efficient C^4I systems contributes to land force dominance. This enables the theater CINC to achieve decisive victory with minimal casualties. The successful integration of the diverse forces and materiel into the four TMD operational pillars enables the Army to accomplish its TMD force protection role and allows friendly forces the freedom of ground maneuver.

Evolving Army TMD doctrine calls for a highly capable and robust ground-based defense that is rapidly deployable and sustainable in contingency theaters to support force projection operations. Army TMD doctrine will coincide with TMD joint doctrine and operational principles described in Joint Publication 3-01.5, *Doctrine for Joint Theater Missile Defense.* Army Field Manual, FM 100-5, *Operations*, the authoritative foundation for subordinate Army doctrine, recognizes that the threat to friendly forces has grown due to the proliferation of WMD and missile delivery system technology. In defining the requirement for force protection in each phase of an operation, FM 100-5 calls for a greater role for TMD as an enabler for the generation of combat power. An active TMD operational concept published by the U.S. Army Training and Doctrine Command (TRADOC) as a precursor to more weapon-specific doctrine, describes how a PATRIOT/Corps SAM/MEADS and THAAD task force will operate to provide a near-leak-proof, two-tiered defense of critical assets within a theater. PATRIOT/Corps SAM/MEADS will provide protection as the lower-tier system in the enclave or in its primary mission of protecting corps critical assets and maneuver forces through all phases of force projection operations from early entry through decisive operations.

Steps to increase proficiency in TMD will include incorporating the theater missile threat and TMD responses into all levels of training and service school programs of instruction, and capturing and understanding the lessons-learned from recent combat experience. TMD will be an integral part of live field training exercises at the combat training centers and the Battle Command Training Program, a training tool for corps and division commanders which uses constructive simulation and situational scenarios to execute large unit operations. As part of the Louisiana Maneu-

vers and the associated battle laboratories, TMD will be examined in detail to provide the best possible combat preparation for commanders, staffs, and soldiers.

2.3.3 Navy Doctrine

The Navy's strategic statement of the naval role, "from the sea," emphasizes the need for naval forces that can operate in any littoral (coastal area) theater to provide a forward presence and a timely, power projection capability. Naval forces can be configured to operate alone or in support of indigenous capability should it exist and, if necessary, to facilitate and support the insertion of follow-on joint or combined expeditionary forces. Accordingly, an important naval role in the post-Cold War era is to provide a prompt, survivable, and sustainable combat force that can effectively project power "from the sea" into theaters of operations.

The inherent mobility of naval forces and their capability for integrated warfighting make them an important foundation for CINC contingency planning and phased response to regional crises. Navy TMD systems are capable of creating an immediate defensive umbrella for expeditionary forces as they assemble and move into the theater of operations. If forced entry is required, the Navy's role will be to provide highly survivable active defense, complemented by attack operations against enemy missile sites and other key targets. Where time urgent command and control of theater air defense is required, the Navy may be assigned duties as the JFACC by the JFC. As joint or combined forces continue to insert capability into the theater and begin to move inland, the Navy's role will expand to include managing and defending the logistics pipeline, as well as extending the reach of attack operations. At that time, JFACC responsibilities may move from being a JFACC afloat to a JFACC ashore.

Naval forces are ideal for employment in the underdeveloped theater where U.S. ground and air forces are limited in extent or capability or for mitigating the liabilities and uncertainties of foreign bases. Naval TMD provides immediate, visible support for allies while acting as a nonintrusive catalyst for increased cooperation among future coalition members. Vital national interests could be protected from the sea due to optimum positioning flexibility for over water and coastal enemy TBM trajectories. By stationing firing units at sea, rules of engagement may also be more flexible than for batteries based ashore on foreign soil.

Command and control issues are being updated in operational doctrine and Concepts of Operations (CONOPS) at the training commands and the Naval Doctrine Center. The revised CONOPS will be incorporated in shore- and sea-based training. Within a theater-level architectural perspective, all functional areas, from intelligence and surveillance to post-engagement assessment, are being scrutinized for optimum effectiveness in joint and combined operations. Operational demonstrations and experiments are used to verify progress in system engineering and doctrine evolution. Operations of selected fleet units are addressing, as part of a CINC/BMDO-sponsored assessment program (see Section 2.12.1), key TMD issues in preparation for incorporating TMD into training and readiness exercises.

2.3.4 Air Force Doctrine

The Air Force considers theater air defense to be a layered defense employing joint operations. The CONOPS is to destroy the threat as far forward as possible. This requires coordinated and rapid offensive counter-air operations to destroy the threat and its infrastructure prior to launch,

along with complementary and simultaneous defensive counter-air operations to engage and destroy targets in flight before they can threaten friendly forces. These offensive and defensive air operations, coupled with PD, minimize the impact of strikes against allied and U.S. bases and forces. The Air Force's adherence to "global reach/global power" was effectively demonstrated during Desert Shield by its ability to deploy rapidly and establish the defensive posture that, in turn, allowed the other Services to deploy, disembark, and establish their defenses. There is considerable debate over the command of, control of, and relationships among, theater missile defense, theater air defense, and counter-air operations. The Air Force considers theater air defense to be the integrated employment of joint forces to destroy or neutralize enemy offensive aircraft and theater missiles in order to protect friendly forces and vital interests.

The Air Force plays several vital roles in providing a TMD capability to the theater CINCs. The Air Force is meeting the TBM challenge by integrating a mix of mutually supportive PD, AD, AO, and BM/C^4I. The Air Force contributes to the campaign through tactical missile warning, cueing to ground-based forces, offensive and defensive counter-air, and air interdiction capabilities. When the Air Force is assigned duties as the JFACC, it plans and directs the use of assets to achieve air superiority.

Air superiority criteria include detecting, identifying, tracking, intercepting, and destroying enemy aircraft, cruise missiles, theater ballistic missiles, and launchers as well as their associated support infrastructure. Counter-air is the primary mission conducted to attain and maintain air superiority. Successful and timely countering of theater missile threats requires improved sensor target detection, tracking, and identification capabilities; a joint BM/C^4I architecture that includes decision aides; and streamlined execution of command and control functions. The connectivity between Services will allow for mission planning, integrated targeting, retargeting, multiple engagements, and flexible response options. Procedures and training are being developed to ensure the greatest efficiency of a multilayered TMD capability. Attacking mobile targets within minutes and seconds must become routine and requires full integration of all assets.

BMDO and the U.S. Air Force are pursuing the development and advancement of systems and technologies that can conduct the Boost Phase Intercept (BPI) mission. The leading technology is the Airborne Laser (ABL). A backup boost phase, kinetic energy missile is also being pursued by the DoD. Current activity is structured to provide an answer to issues relating to operations, force structure, and affordability of the ABL. The ABL may provide warfighting capability which currently is nonexistent, i.e., killing missiles in their boost phase to (1) preclude the use of advanced penetration aids and terminal defense saturation, (2) facilitate multiple engagement opportunities, and (3) put enemy territory at risk from rocket and warhead debris. The BPI capability, in conjunction with terminal defenses, will provide a truly layered defense against TBM threats.

2.3.5 Marine Corps Doctrine

The 1992 Marine Corps TMD Mission Need Statement outlined the Marine Corps' requirement for a TMD capability. As a result, the Marine Corps analyzed the current anti-air warfare doctrine to identify doctrinal changes and analyzed the Marine Air Command and Control System (MACCS) for required equipment improvements.

Marine Corps TMD doctrine is an outgrowth of existing Naval anti-air warfare system doctrine. This involves most of the existing command and control facilities and weapon systems, modified

by the expanding threat and new operational concepts. In addition, Marines will capitalize on a long tradition of littoral operations to provide a seamless transition of joint expeditionary warfighting "from the sea" to maneuver ashore. Marine TMD operations will be characterized by flexibility, adaptability, and interoperability. Whether fulfilling the mission of the landward sector of the Naval TMD umbrella, bridging the transition of JFACC/AADC responsibilities from the Navy to the Army/Air Force inland, or contributing to the joint or combined structure during a sustained campaign, Marine doctrine and forces will be capable and compatible. Marine TMD forces are characterized by rapid deployability, sustainability, and instant readiness and are able to build quickly upon forward deployed units and maritime prepositioned forces to provide a CINC a tailored, integrated, and interoperable Marine Air Ground Task Force (MAGTF).

Marine Corps TMD operations fall under Marine Corps anti-air warfare system operations in joint, naval expeditionary, and amphibious operations. In joint operations, the Marine component commander or MAGTF commander is responsible to the JFC for Marine Corps TMD operations within the assigned area of operations. The MAGTF commander may delegate authority to the Aviation Combat Element commander for MAGTF TMD operations (exercised through the Marine Tactical Air Command Center). The Aviation Combat Element commander may further delegate authority to the MAGTF active TMD operations within the MAGTF's area of operations to Sector Anti-Air Warfare Coordinators (SAAWC)/Tactical Air Operations Center (TAOC). The Marine Aviation Combat Element and SAAWC/TAOCs coordinate TMD operations with the JFACC and AADC. The MACCS, specifically the radars of the TAOCs/(TPS-59), provide surveillance, early warning, and cueing for the MAGTF.

In naval expeditionary and amphibious operations, the MAGTF commander is designated as the Commander, Landing Force. Initially the Navy's Commander, Amphibious Task Force, is responsible for all TMD operations within the amphibious operative area. The Commander, Landing Force, becomes responsible for those sectors of the amphibious operative area assigned by the Commander, Amphibious Task Force, usually the landward sectors, when the means to command, control and defend the sectors are established ashore. Depending on the situation and mission, overall authority for TMD operations in the amphibious operative area can be passed ashore. When agreed to by the Commander, Amphibious Task Force, and Commander, Landing Force, and when the MACCS is capable, overall authority for TMD operations may be passed from the Navy to the Aviation Combat Element commander/AADC. After control is passed ashore, the Marine Aviation Combat Element ashore and SAAWC/TAOC coordinate TMD operations with the Navy, as required, and with other participating TMD command and control centers and weapon systems of the joint or combined forces.

The Marine Corps identified deficiencies in the MACCS and initiated upgrades to existing weapons systems, i.e., the HAWK missile system and the TPS-59 radar to provide a point defense capability for the MAGTF. In addition, the Marine Corps has expressed an interest in Corps Surface to Air Missile/Medium Extended Air Defense System (SAM/MEADS). A joint memorandum of agreement, signed by the Vice Chief of Staff for the Army and the Assistant Commandant of the Marine Corps, identifies the Marine Corps requirement for Corps SAM/MEADS.

2.4 Force Structure

The following sections describe the TMD force structure plans for the Army, Navy, Air Force, and Marine Corps.

2.4.1 Army

The Army's planned force structure consists of PATRIOT, THAAD, Corps SAM/MEADS, and Joint Tactical Ground Station (JTAGS). Currently, the PATRIOT force structure is comprised of 10 operational PATRIOT battalions containing 50 tactical fire units with an additional 4 fire units being fielded with the Alabama National Guard. Of the U.S. forces, six fire units are being used for Southwest Asia rotation and one battalion has been sent to South Korea to support U.S. forces. In addition to the U.S. force, 12 fire units are manned by German forces.

Two THAAD battalions, each with four firing batteries, are planned for fielding early in the next decade. The THAAD Program also plans to deliver a functional, developmental prototype system at the end of its Program Definition/Risk Reduction (PD/RR) phase. This system, referred to as the THAAD User Operational Evaluation System (UOES), will be used for Engineering and Manufacturing Development (EMD)-phase testing and will provide the means for early training. In the event of a national emergency, the UOES could become a deployable prototype system. This system will be based at Fort Bliss, Texas, and could be rapidly inserted into any theater using current military transport aircraft.

The Army plans to deploy six Corps SAM/MEADS battalions starting in 2005 pending an acquisition funding decision in FY 1998. It is envisioned that two Corps SAM battalions, each with three firing batteries, will support a corps size element. Along with the manpower savings, there will be a marked improvement in strategic and tactical deployability. It will have a C-130 roll-on/roll-off capability that allows Corps SAM/MEADS to deploy rapidly to theater utilizing less transportation assets.

Five JTAGS units, including two refurbished units, will be fielded starting in FY 1997 to provide in-theater processing of DSP satellite data for warning, alerting, and cueing of TBM launches. The JTAGS units will be deployed in pairs during wartime or contingency operations to ensure availability on a continuous basis. The current plan is to forward-deploy one section of each detachment during peacetime. The JTAGS is the in-theater element of the United States Space Command (USSPACECOM) Tactical Event System (TES).

2.4.2 Navy

The Navy Theater Ballistic Missile Defense (TBMD) Program is based on evolving the inherent air defense mission capabilities of AEGIS ships to contend with the unique intercept requirements posed by TBMs. The first stage of evolving this capability is called the Navy Area TBMD Program. During this stage the AEGIS combat system will be modified to support area TMD and the STANDARD Missile-2 will be modified to the Block IVA TBMD configuration. This area defense program will provide a lower-tier or endoatmospheric intercept capability. The second evolutionary stage of the Navy program will expand the battlespace by building on the combat system of the Navy Area TBMD system and developing an exoatmospheric (upper-tier) interceptor to provide a theater-wide TBMD capability to conduct ascent phase intercept against WMD. TBMD

capability upgrades will be fully integrated with the AEGIS multi-mission capability in all four pillars of TMD.

The Navy's theater air defense architecture supports varying levels of theater-of-operations maturity. During the early stages of any conflict, a Navy carrier battle group may be the only U.S. or allied theater air defense capability in the theater. The carrier battle groups provide an initial capability to gain and maintain air control, possibly air superiority, and a complementing capability to defend coastal areas and counter strike against TBM attacks. AEGIS ships within the battle group command and control structure can operate autonomously with or without indications and warning from national sensors. Within the battle group, coordination would be performed via Link-16 with Link-11/voice backup for engagement status. Indication and warning messages would be provided on the Tactical Related Applications Program (TRAP) broadcasts and integrated into the system via Tactical Receive Equipment (TRE).

During amphibious operations, the role of the carrier battle group is to maintain air control and provide defense of forces moving ashore from the sea. AEGIS ships will perform the same functions described above for the underdeveloped theater with the additional responsibility of coordinating with USMC HAWK batteries for engagement status and cueing. As Army systems or other allied land forces are inserted into the theater of operations, the role of the carrier battle group will continue as before, and the AEGIS ships' role will be expanded to provide coordinated battlespace coverage with PATRIOT batteries, e.g., to provide engagement status and cueing. Finally, in a mature theater, the carrier battle group with its TMD-capable AEGIS ships, will be available to support TBM defense, counter forces, and cueing of other allied systems.

The near term Navy program will use TRAP/TRE and the Joint Tactical Information Distribution System (JTIDS) to the greatest extent possible. JTIDS, the Joint/NATO program which uses Tactical Digital Information Link (TADIL-J) or Link-16 messages, has been selected as the principal tactical communications system to support the TBMD mission. Joint or combined combat systems that may use the JTIDS network will receive all or portions of this information depending on their needs. Joint or combined systems that may use the JTIDS network include Airborne Warning and Control System (AWACS), Joint Surveillance Target Attack Radar System (JSTARS), Airborne Battlefield Command and Control Center (ABCCC), Control and Reporting Center (CRC), Air Defense Tactical Operations Center (ADTOC), PATRIOT, THAAD, E-2, CV/CVN, LHD, LHA, CGN 36/27, DDG 993, TAOC, and HAWK. A Link-11 TBMD capability will be maintained for backup and beyond-line-of-sight connectivity. The Link-11 TBMD data will be the same as the Link-16 data. New messages are being developed to implement this commonality.

The AEGIS Combat System will be equipped with TRE to provide data to the AEGIS Weapon System (AWS) from national assets (procurement and installation will be paid for by the Navy). TRE provides the capability to receive Tactical Data Information Exchange System B (TADIXS-B) and TRAP data.

The current command and control architecture provides a solid foundation for TBMD. The intrinsic Command and Control (C^2) capability of the AEGIS Combat System supports a rapid exchange of data over a variety of external C^2 networks. The possible future integration of the Navy's Joint Maritime Command Information System (JMCIS) will broaden this capability with increased connectivity to joint Service C^2 systems. Development and integration of overall TBMD

battle planning functions into the Area TBMD program are under study, including their incorporation into tactical and operational documentation/doctrine. Computer program modifications to non-AEGIS Navy command and control participants in support of C^2 have been defined.

The Navy plans to achieve an Area theater ballistic missile defense contingency capability by 2000 with a UOES on at least one AEGIS ship. The user evaluation of the UOES in conjunction with testing at shore engineering support activities will provide significant opportunity for further development and validation of doctrine and tactics in both Navy and joint or combined warfare environments.

2.4.3 Air Force

Theater Air Defense is represented by four pillars--AO, AD, PD and BM/C^4I. The objective of the first pillar of attack operations is to destroy TBM launchers, missiles, support, and command and control infrastructure. In attack operations, destruction of TBMs and their infrastructure on the ground as early as possible in their life cycle is the first priority, referred to as prelaunch destruction. This involves preplanned attacks against the manufacturing and logistics infrastructure (the uncommitted phase) and preemptive attack against missiles in the forward area preparing for launch (the committed phase). The post-launch phase includes attacks by combat air patrol missions assigned against these time critical targets as well as attacks by redirected or retasked aircraft. Today, the Air Force possesses aircraft and weapons that can be employed to destroy a transporter erector launcher, classified as a soft target. The challenge is detecting and identifying these targets and then tasking the most appropriate resources to engage and destroy them within the shortest possible timeline. This drives the requirement to improve the connectivity for the current Theater Air Control System (TACS).

Active defense, the second pillar, protects assets and forces from attack by destroying airborne launch platforms and/or theater missiles in flight. Limited in Desert Storm to terminal intercepts by PATRIOT, the future architecture must be able to engage theater ballistic missiles throughout the entire missile flight profile. A multilayered defense provides multiple opportunities to negate theater missiles, increases the probability of kill, and prohibits the enemy from being able to counter the defensive system with a single technique or countermeasure. The Air Force's principal contribution to this multilayered architecture will be the development of a BPI capability. Attacking in the boost phase offers the greatest potential for eliminating problems associated with the type of warhead with submunitions that can be released before the missile can be engaged by non-boost phase defenses. Hitting missiles during their boost/ascent phase requires rapid response, since the missiles boost for only 60-150 seconds. By destroying a missile early in the boost phase, the system places the enemy in the potential position of having its own TBMs fall upon its territory. Thus, BPI provides enhanced deterrent capability to the BMD architecture.

The Air Force is acquiring the ABL to meet BPI requirements. The ACAT-ID acquisition program will integrate a high energy chemical laser, beam control utilizing adaptive optics compensation, and a battle management suite on to a 747-400 wide body aircraft. The development program will demonstrate the robust, high altitude standoff, theater missile defense capability achievable using the ABL. The Air Force is developing and has fully funded the Airborne Laser, which adds speed-of-light to the weapons solution and offers the most immediate promise to achieve the desired boost phase kills. Just as the time-sensitive nature of attack operations requires improvements in the TACS structure, so does BPI.

The third pillar, passive defense, strives to minimize the effect of theater missiles on U.S. and friendly forces and their operations. In addition, passive defense provides the capability to effectively recover and reconstitute forces following an attack. Effective passive defense employs several complementary techniques, among them hardening, dispersion, camouflage, cover, concealment, and timely warning of threat attacks.

All three of these pillars--AO, AD, and PD -- rest on effective BM/C^{4}I. A well-defined and effective BM/C^{4}I network will enable the JFACC/AADC to exercise C^2 over battlefield assets. Accurate intelligence will enhance the JFACC's ability to make the right decisions and quickly supply the shooters with the information they need to destroy the enemy.

The Air Force already has a system for conducting counter-air operations--the TACS. The Air Force TACS includes the organization, personnel, procedures, and equipment necessary to plan, direct, control, and coordinate theater air operations. The TACS elements include the Air Operations Center (AOC), Control and Reporting Center (CRC) with its Combat Integration Capability (CIC), AWACS, and JSTARS. The AOC, as the senior element of the TACS, can link national and theater sensors, intelligence, and communications with other Service or component operations centers to plan, coordinate, and integrate all the operational elements of TAD into offensive and defensive counter-air operations. TACS has already worked well for such missions as offensive and defensive counter-air operations, and the Air Force believes the same system will continue to work for theater missile threats.

The Air Force is responsible for space-based TBM launch detection and warning. Currently, space-based ballistic missile launch detection is accomplished by DSP satellites. Fixed and mobile DSP data processing centers transmit strategic launch detection and missile parameter information to the Combat Operations Center at Cheyenne Mountain, Colorado. This information is then evaluated and forwarded to end users such as the National Military Command Center and U.S. forces worldwide. The Attack and Launch Early Reporting to Theater (ALERT) system processes data from multiple DSP satellites at a processing center at Falcon Air Force Base and transmits warning of tactical missile launches over the Tactical Information Broadcast Service (TIBS) and TRAP Data Disemination System (TDDS) networks. This processing is done in near real-time to meet in-theater tactical response timeline requirements. DSP data can also be processed directly in the theater for tactical applications and for processing by other systems.

DoD designated the Air Force its executive agent for theater air defense BM/C^{4}I. As the executive agent, the Air Force is responsible for constructing a theater air defense BM/C^{4}I architecture that will provide the CINCs a flexible system to integrate joint forces and all operational elements required to counter-air and missile threats. Requirements for TMD BM/C^{4}I are being coordinated with AF/XOR, the office designated by the Secretary of the Air Force as the Executive Agent for Theater Air Defense.

2.4.4 Marine Corps

The Marine Corps force structure is evolving a TMD capability through the modification and upgrade of existing weapon systems. Initial operating capability will provide TMD detection and engagement in FY 1998. A full operational capability with improved C^2 will be fielded in FY 1999-2000. Marine TMD force structure consists of the following elements:

- Tactical Air Command Center (TACC). A command and planning level facility which receives, processes, and transmits TBM/aircraft targeting information to other elements via digital data communications. There are four TACCs in the operating forces.

- Tactical Air Operations Center (TAOC). A control and coordination facility which provides TBM target data to the weapon elements via digital data. There are six TAOCs in the operating forces.

- TPS-59 Radar. Provides surveillance, early warning and weapons cueing for the MAGTF. The upgraded version will detect, track, and process TBM targets for the TAOC including launch point estimates and impact point predictions. It will retain its air breathing target detection capabilities. There are 11 TPS-59 radars in the Marine Corps with 6 in the operating forces.

- Air Defense Communications Platform (ADCP). Provides a communications interface from the TPS-59 radar at the TAOC for the JTIDS/TADIL-J data network. There will be 12 ADCPs in the operating forces at the HAWK missile system fire units.

- HAWK missile system. Acquires, tracks, and engages short-range TBM targets. There are 6 batteries of HAWK in the operating forces currently configured to yield 12 firing units.

Based on Defense Planning Guidance and Commission on Roles and Missions language, the Marine Corps expects to transfer its Medium Air Defense mission to the U.S. Army at a date based on expected fielding of Corps SAM/MEADS.

2.4.5 Joint Theater Missile Defense

This section describes the joint force structure and identifies the joint early warning and dissemination systems.

2.4.5.1 Joint Theater Early Warning and Dissemination

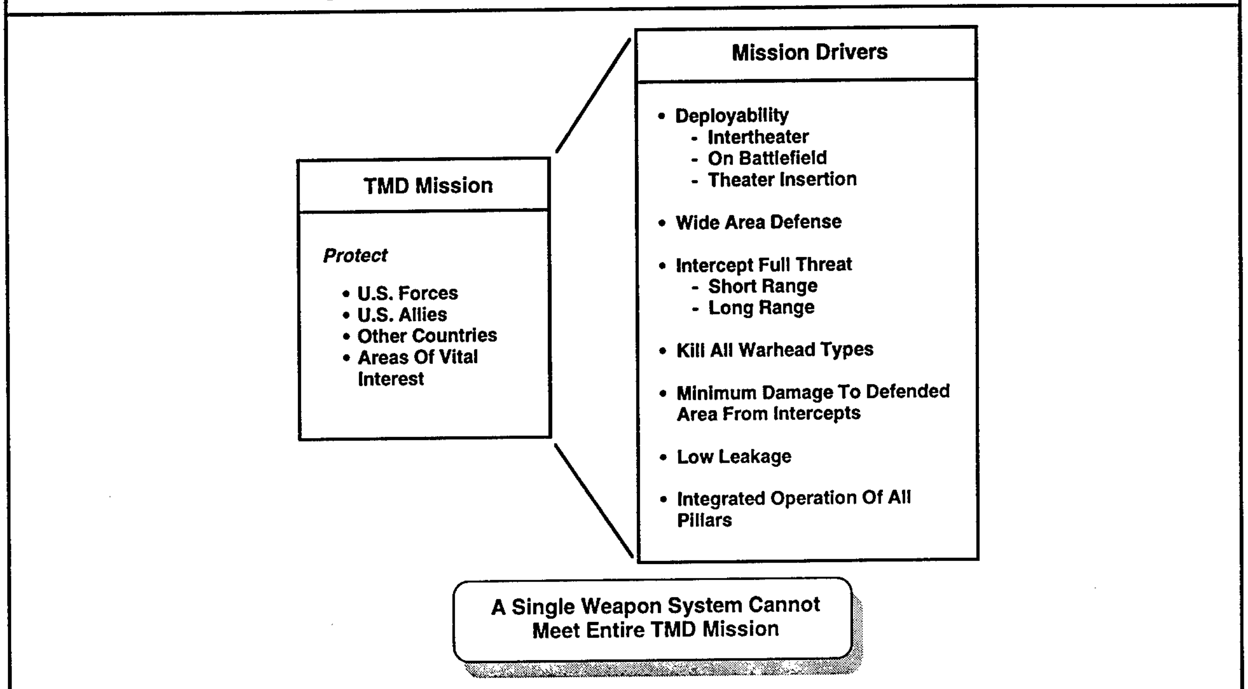
After the Gulf War, the Services recognized the need to improve missile threat warning to their deployed forces. This need resulted in the creation of three complementary systems to process tactical warning data quickly and more accurately and disseminate that information to the theater. Each of the new systems combines inputs from two or more DSP satellites ("stereo" DSP data) with other sources (e.g., national sensors, radar, intelligence) to refine launch point and missile trajectory predictive ability.

The Air Force has developed a prototype for U.S.-based stereo DSP processing called SHIELD. The fielded capability of SHIELD, designated ALERT, provides theater commanders with continuous, accurate launch warning and tracking data. A Navy demonstration of a related technology, begun as Radiant Ivory, will become operational as Tactical Detection and Reporting (TACDAR). Finally, JTAGS is a joint Army-Navy program for in-theater DSP data processing and distribution. It will be formally fielded in FY 1997.

2.5 TMD Active Defense Framework

The 1993 Theater Missile Defense Initiative Report to Congress presented a framework and architecture developed from operational and technical attributes. BMDO continuously evaluates the TMD mission, threat characteristics, and doctrine and updates the mission drivers and desired TMD performance characteristics. The TMD Cost and Operational Effectiveness Analysis (COEA) completed in FY 1996 is an example of a recent evaluation. The TMD COEA reaffirmed that "a single weapon system cannot meet the entire TMD mission." This continuous process ensures that the framework and architecture meet the TMD system requirements. Figure 2-5 shows the TMD mission and resultant mission drivers.

Figure 2-5. TMD Active Defense Mission Drivers



The mission drivers are used to identify the key performance characteristics of the TMD system. Figure 2-6 shows the resultant performance characteristics.

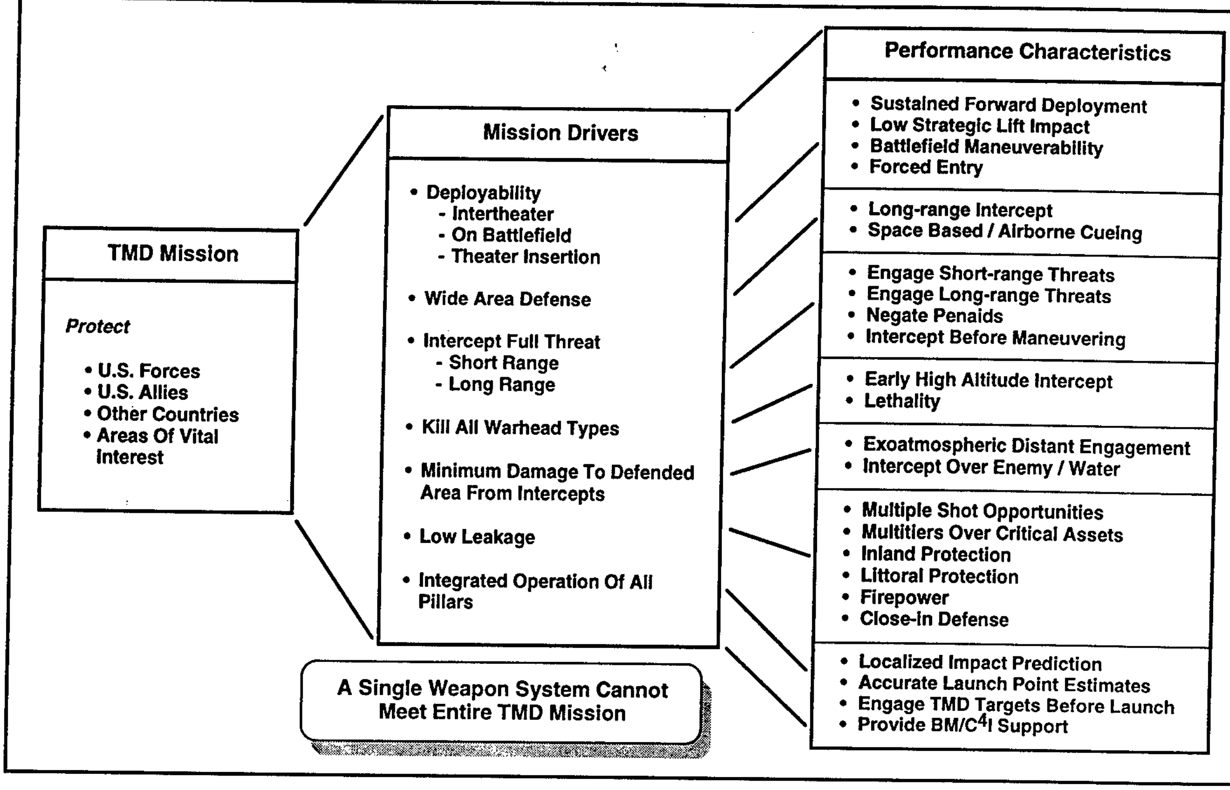
An examination of these performance characteristics leads to the conclusion that boost phase, upper, and lower-tier TMD systems consisting of land, sea, and air forces provide the most effective framework for TMD. This framework is shown in Figure 2-7.

As indicated, BM/C^{4}I remains the critical element that ties the other elements together.

2.6 Acquisition Strategy

The TMD program continues to be DoD's top priority in providing U.S. forces a highly effective AD capability. As such, the acquisition strategy for the TMD program is geared toward the robust

Figure 2-6. TMD Performance Characteristics



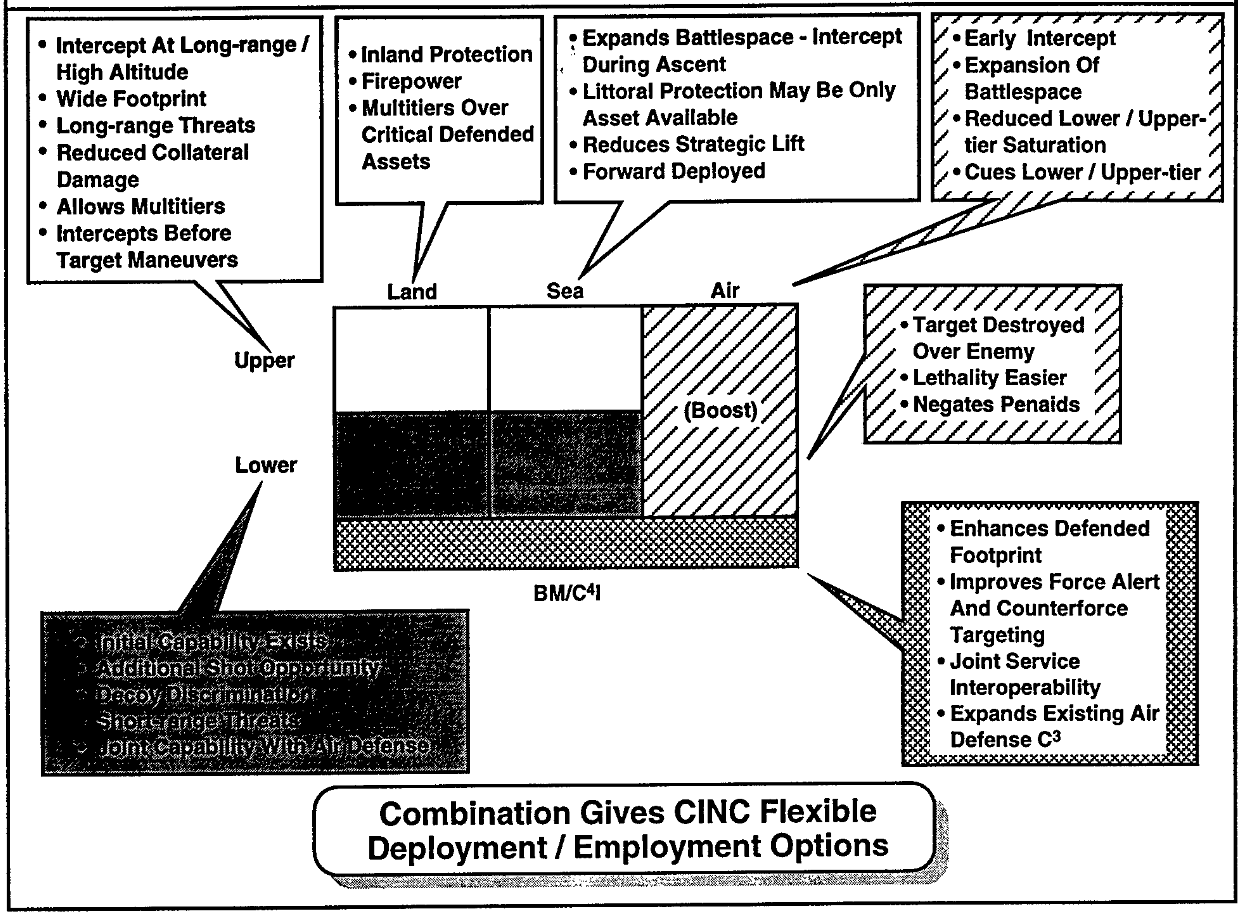
and early deployment of improved missile defenses, and to respond quickly to the theater-level threat. The DoD's strategy includes maximizing prior investment in ongoing Service programs and the existing infrastructure, and minimizing risks associated with both developing and introducing the new capabilities into the existing force structure.

In early 1996, the DoD completed a BMD Program Review which reaffirmed the TMD program priority status. In this review, DoD refined the underlying TMD acquisition strategy to address increased program risk areas, enhance overall TMD program balance and affordability, and synchronize the program schedule with the existing and emerging missile threats. The current strategy also accounts for all FY 1997 funding requested by the President, as well as the funds that were added by Congress.

Similar to last year's plan, the first thrust of the TMD program is to complete the near term improvements to the missile defense systems that are currently fielded. These include the Army's PATRIOT Advanced Capability-2 (PAC-2), the Marine Corps' HAWK missile system, and other joint sensor cueing and communications systems. These improvements are nearing completion, resulting in substantial performance gains over which U.S. forces were able to provide during the Desert Storm campaign. The balance of the TMD acquisition strategy focuses on the remaining TMD priority areas, namely:

- Acquisition Programs
  - Lower-tier (or area defense) systems;
  - Upper-tier (or theater-wide defense) systems;

Figure 2-7. TMD Active Defense Framework



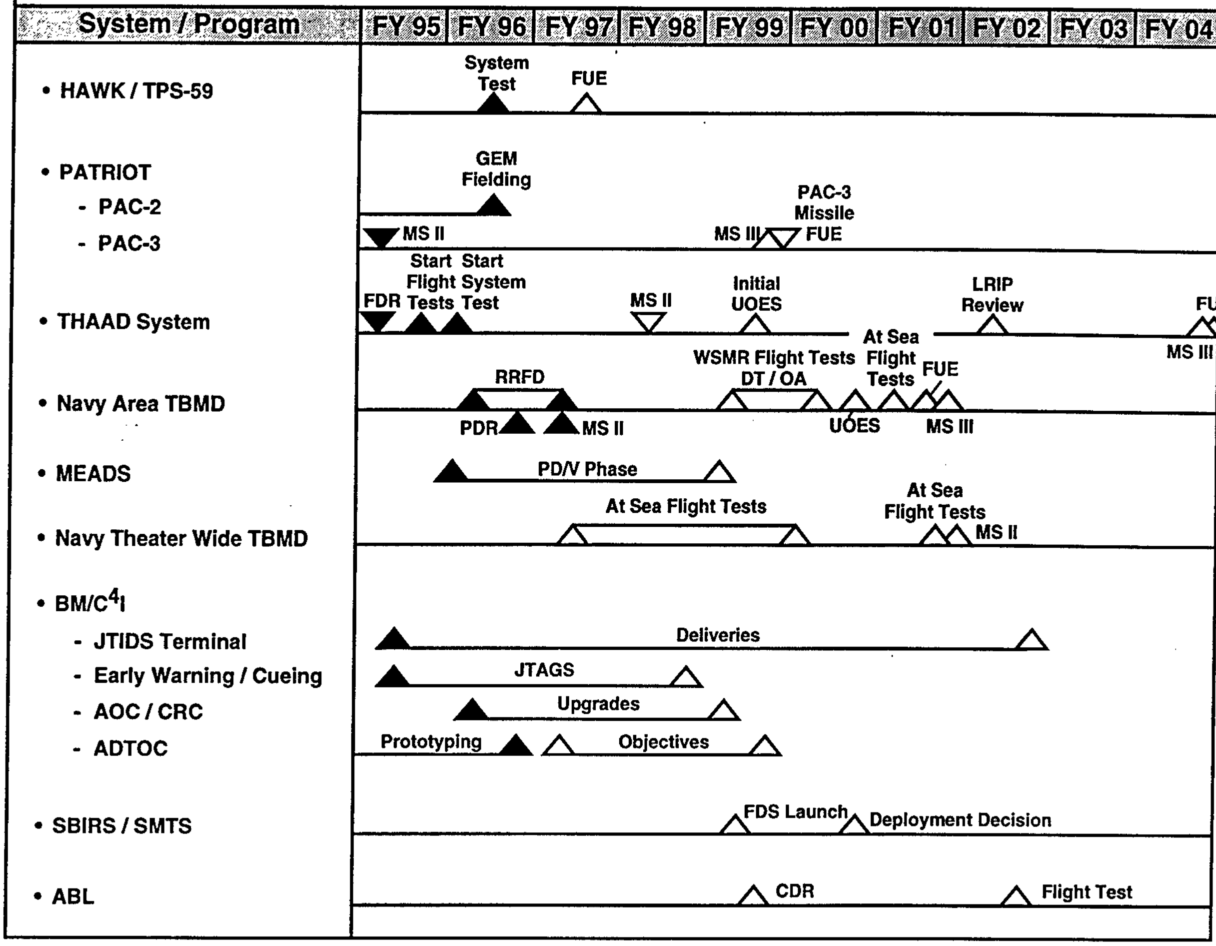
- BM/C^4I Improvements and Upgrades;
- Other Concepts;
- Joint TMD Support Programs.

The current strategy also includes the operational employment of systems developed during the PD/RR and EMD phases of the acquisition process. These UOES serve four purposes: (1) influence the engineering and manufacturing development program by getting users involved early; (2) provide systems for testing, evaluating, and training as part of the normal acquisition process; (3) refine operational doctrine and organization structures; and (4) provide a contingency defense capability should the need arise in an emergency prior to production and deployment. The acquisition program for THAAD and the Navy Area TBMD program include provisions for UOESs. The Air Force ABL PD/RR aircraft will provide some Residual Operations Capability prior to the EMD and production phases.

2.7 Master Schedule

Figure 2-8 shows the master schedule for the TMD core programs. The schedules have been adjusted to reflect the current year budget (FY 1997) and the FY 1998 President's Budget.

Figure 2-8. TMD Master Schedule



2.8 Near Term Improvements

Near term improvements increase existing theater missile defense capabilities until the core programs are available at the end of the decade. These improvements are PATRIOT Advanced Capability-3 (PAC-3) upgrades, TPS-59 radar and HAWK modifications, and BM/C^{4}I improvements including sensor cueing upgrades.

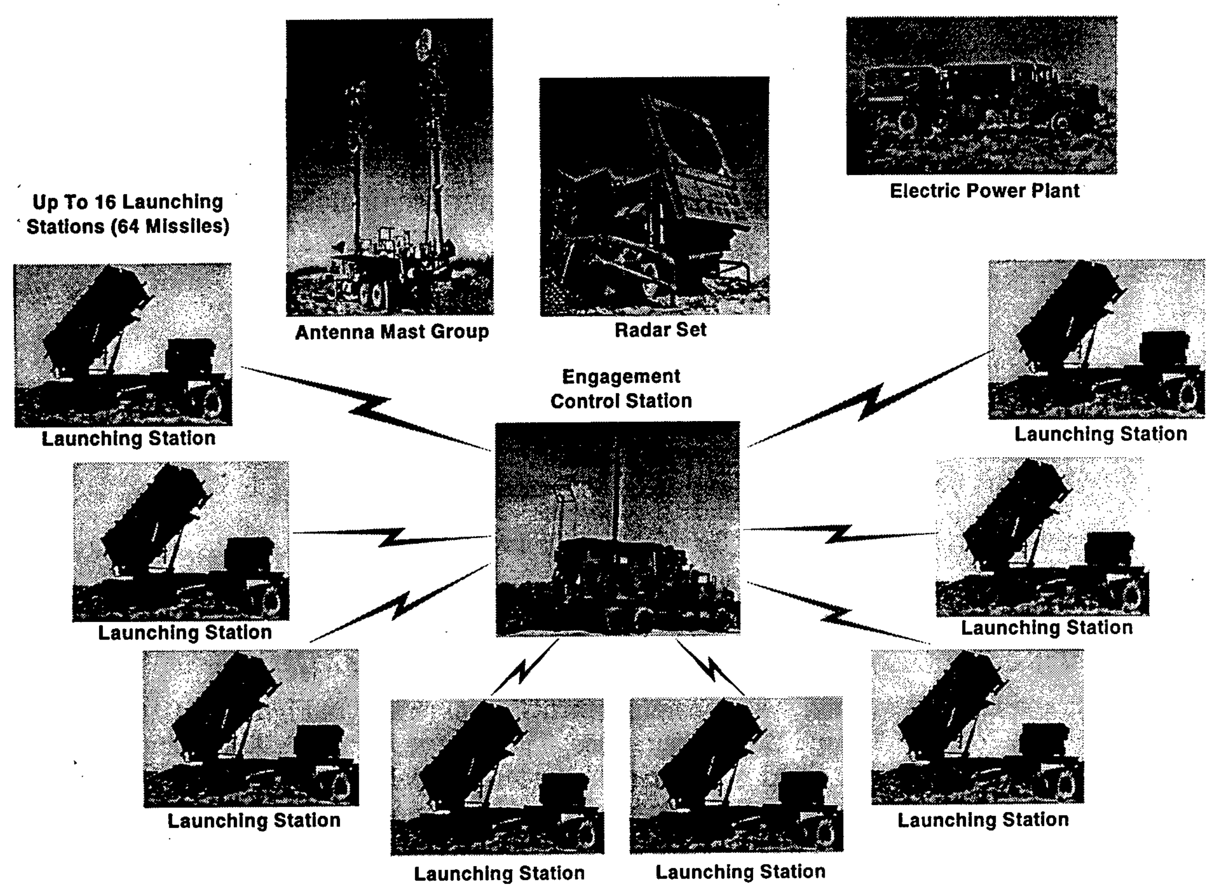
2.8.1 PATRIOT Advanced Capability-3 (PAC-3)

Recent upgrades to the PAC-2 system consist of the Quick Reaction Program (QRP) and a Guidance Enhancement Missile (GEM). Current upgrades under the PAC-3 Program are packaged into three configurations. Configuration 1 will complete fielding in FY 1997 while Configuration 2 fielding is ongoing. Configuration 3 First Unit Equipped (FUE) is scheduled for FY 1999, and will include the deployment of PAC-3 missiles to augment the existing inventory of PAC-2 and GEM missiles.

PATRIOT is an air defense guided missile system designed to cope with the air defense threat of the 1990s, characterized by defense suppression tactics using saturation, maneuver, and electronic

countermeasures. The principal element of the PATRIOT organization is the battalion, which consists of up to six firing batteries. Battalions normally deploy at echelons above the corps and as part of the corps air defense artillery brigade. The PATRIOT battery, also referred to as a fire unit, is the smallest element capable of engagement operations. The PATRIOT firing battery, shown in Figure 2-9, includes the fire control section and normally eight Launching Stations (LS), although a battery has the capability to control up to 16 launching stations. The fire control section consists of a Radar Set (RS), Engagement Control Station (ECS), Antenna Mast Group (AMG), and Electric Power Plant (EPP).

Figure 2-9. PATRIOT Firing Battery



The need for an anti-tactical missile capability was identified in the 1980s from the deployment of large numbers of accurate Soviet tactical ballistic missiles in eastern Europe. The PATRIOT Advanced Capability-1 (PAC-1) and PAC-2 programs were developed to provide the PATRIOT system with additional capabilities to defend itself and critical assets against TBM threats and continue to carry out its primary mission.

The PATRIOT QRP was instituted in 1991-1992. This program, designed to identify and field improvements quickly to correct Desert Storm shortcomings, includes emplacement upgrades for rapid, accurate fire unit emplacement, a capability to deploy remote launchers up to 10 km from the radar, and radar enhancements to improve TBM detection and increase system survivability.

The QRP configuration of PATRIOT is already operational and deployed in Saudi Arabia. All U.S. PATRIOT fire units have been converted to the QRP configuration.

GEM is a companion program to the QRP. GEM includes engineering improvements to the PAC-2 missile to increase effectiveness and lethality, especially against the Desert Storm-class of TBM threats, by modifying the receiver and fuzing. GEM fielding began in FY 1995 and a total quantity of 345 (180 new and 165 retrofitted) missiles will be procured by the end of FY 1997.

FY 1996 efforts resulted in the following accomplishments:

- Continued delivery of GEM missiles;
- Completed fielding of QRP-configured National Guard Battalion;
- Completed fielding of the QRP battalions;
- Continued fielding of PAC-3/Configuration 1 upgrades (including GEM deployment);
- Completed FUE for PAC-3/Configuration 2 upgrades.

Work planned for FY 1997:

- Complete delivery of GEM missiles;
- Continue fielding of Configuration 2 upgrades;
- Initiate Flight Test Program for the PAC-3 missile and PAC-3 Configuration 3 system.

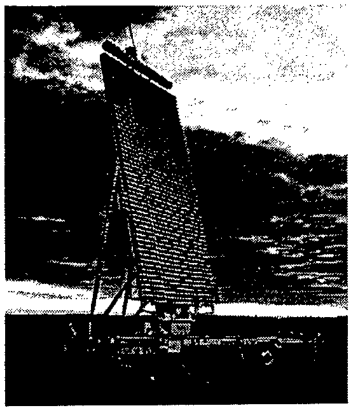
2.8.2 Marine Corps Theater Missile Defense Initiative (TMDI)

TPS-59 radar and HAWK weapon system improvements, summarized in Figure 2-10, will provide a TMD capability for U.S. Marine Corps operations. The Marine Corps TMD Initiative is jointly funded with BMDO and will yield a low-risk, near-term capability for expeditionary forces against short-range ballistic missiles. The program consists of modifying the TPS-59 long-range air surveillance radar and the HAWK weapon system to allow detection, tracking, and engagement of short-range TBMs. The program will also provide a communications interface by developing an ADCP.

The TPS-59 radar serves as the primary sensor for the Marine TAOC, which is responsible for conducting all Marine Corps anti-air warfare functions including the control of friendly aircraft and missiles. The TPS-59 radar's mission includes detection of up to 500 targets consisting of a mix of aircraft, both fixed and rotary wing, cruise missiles, and tactical ballistic missiles. The modifications to the TPS-59 radar increase the radar's ability to detect small radar cross section targets and adds a tactical ballistic missile detection and tracking capability. As a result of these modifications, the TPS-59 radar will provide surveillance at ranges out to 400 nautical miles (750 kilometers) and at altitudes up to 500,000 feet (150 kilometers).

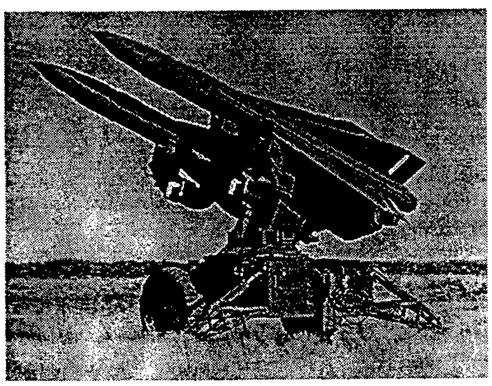
The HAWK weapon system modifications include upgrades to the battery command post and improvements to the HAWK missile that increase the missile's lethality against tactical ballistic

Figure 2-10. TPS-59 Radar And HAWK



BMDO Funded

- Upgrade TPS-59 To Provide Enhanced TBM Surveillance And Tracking Capability
- Air Defense Communications Platform To Act As A Node For Tactical Nets
  - Make TPS-59 Data Available On A JTIDS Net
- Modify Battery Command Post To Accept TPS-59 Data, For Acquisition By HAWK Illuminator Radar
- Upgrade HAWK Missile Fuze And Warhead For TBM Engagements



USMC Funded

- Upgrade Of HAWK Launcher To Interface With Digital Missiles
- Upgrade Of HAWK Launcher To Increase Mobility
- TPS-59 Modification Kit Procurement

missiles. The modified HAWK battery command post will process cueing data from remote sensor systems and control the HAWK High Power Illuminator Radar. The improved lethality missile will incorporate fuze and warhead modifications. Three hundred improved lethality missiles have been transferred from the Army to the Marine Corps. Another 700 missile modification kits will be procured by the end of FY 1997. Production of the battery command post modification kits began during FY 1995. The installation of all battery command post modifications kits was completed during FY 1996.

The ADCP will convert TPS-59 data messages and TADIL-J formatted messages into the intra-battery data link formats required by the HAWK weapon system. The ADCP will also transmit TADIL-J formatted messages to other theater sensors. This communications interface is currently in development and initial production will begin in FY 1997.

During FY 1996, the TPS-59 and ADCP completed operational testing and evaluation at White Sands Missile Range, New Mexico. A successful TMD demonstration was conducted as part of that test. This demonstration, consisting of live fire intercepts of Lance missiles on 50 to 130 kilometer trajectories, was highlighted by the multiple simultaneous engagement of a Lance missile and two air breathing threats. A Milestone III decision for the TPS-59 was made in December 1996. The Milestone III decision for ADCP is scheduled for FY 1997. No BMDO-funded activities are planned for FY 1998 and beyond.

FY 1996 efforts resulted in the following accomplishments:

- Completed TPS-59 operational testing for Milestone III (Production Decision);
- Completed TMD demonstration;
- Completed Battery Command Post Modifications;
- Initiated Improved Lethality Missile modification procurement;
- Completed HAWK additional fuze modification procurement;
- Initiated ADCP long lead item procurement.

Work planned for FY 1997:

- Complete the evaluation of operational testing results;
- Complete Milestone III (Production Decision) for ADCP;
- Initiate TPS-59 modification kit procurement;
- Initiate ADCP procurement;
- Complete Improved Lethality Missile modification procurement;
- Demonstrate TADIL-J connectivity with other Services/systems.

2.8.3 BM/C^{4}I Improvements

Battle Management/Command, Control, Communications, Computers, and Intelligence (BM/C^{4}I) is the critical component that ties the family of systems together. While each system of the family can effectively fulfill its unique mission as a stand-alone element, BM/C^{4}I allows the synergy of systems to significantly improve effectiveness, increase defended area footprint, and reduce leakage of hostile missiles through the theater missile defense. Two areas of near term BM/C^{4}I improvements are early warning and dissemination and sensor cueing capabilities. These activities directly support the ongoing developmental efforts described in the BM/C^{4}I in Section 2.10.

2.8.3.1 Early Warning

Early warning improvements address shortcomings from Desert Storm. These improvements provide earlier targeting opportunities for active defense elements and earlier warning for passive defense. Counterforce strikes may also benefit from better launch point estimates. The complementary programs that provide these improvements are the Air Force's ALERT Program, the Navy's TACDAR Program, and the Army-Navy JTAGS Program. The complementary capabilities of these programs are integrated within the USSPACECOM Tactical Event System (TES). TES will meet the TMD requirements for launch detection and warning as tactical processors mature from demonstrations to full operational capability.

These early warning programs will interface with the TDDS, TIBS, and other tactical data networks to provide a robust capability for all Service users. SHIELD (formerly Talon SHIELD) is a BMDO-sponsored design, development, demonstration, and test platform for multisensor data

fusion and communications processor. SHIELD, collocated with its operational version, ALERT, at Falcon Air Force Base, Colorado, currently processes and fuses multisensor DSP and classified sensor data. The operational ALERT system provides theater commanders with continuous, accurate launch warning and tracking data. SHIELD is also the design, development, demonstration, and test platform for JTAGS. ALERT is the first system sponsored by BMDO to achieve operational status. TACDAR processes classified data from a unique sensor. It also provides the data to ALERT for fusion with data from other sensor assets. The JTAGS Program is a tactical mobile stereo DSP ground station for use in the theater. JTAGS processes sensor data from up to three DSP sources. The JTAGS Program utilizes ruggedized hardware and software developed by the BMDO-sponsored Tactical Surveillance Demonstration (TSD) and the Army- and Navy- sponsored Tactical Surveillance Demonstration Enhancement (TSDE) Programs.

Processor improvements and developmental and operational testing were conducted in FY 1995 and continued in FY 1996. Significant SHIELD tests included demonstration of multiple satellite data fusion against cooperative launches and targets of opportunity. ALERT achieved initial operational capability on March 10, 1995. The Army conducted JTAGS EMD phase technical and operational tests during FY 1995. The Air Force conducted technical testing for the Space Based Infrared System (SBIRS)-Low Altitude component flight demonstration system and continued development during FY 1996. All of these activities will be continued in FY 1997.

FY 1996 efforts resulted in the following accomplishments:

- Using SHIELD, completed integration of a classified suite of surveillance sensors and transferred capability to ALERT and JTAGS;
- Tri-Service (Army/Navy/Air Force) agreement on SBIRS development of a joint service common multi-mission mobile processor;
- Demonstrated improved launch detection and early warning performance with targets of opportunity worldwide;
- Using SHIELD, demonstrated improved data fusion from multiple satellite sensors worldwide and transferred capability to ALERT and JTAGS;
- Performed risk reduction efforts for SBIRS using SHIELD;
- Completed JTAGS developmental and operational testing;
- Began JTAGS production;
- Continued the rehost of the Composite Tactical Display/Generic Area Limitation Environment to a Silicon Graphics Incorporated (SGI) platform using SHIELD.

Work planned for FY 1997:

- Continue SHIELD/ALERT test and evaluation activities;
- Initiate JTAGS Pre-Planned Product Improvement (P^3I) Fusion effort to implement data fusion with TACDAR and other potential sensor sources to improve attack operations as well as active and passive defense;

- Initiate JTAGS P^3I Beacon effort to further reduce DSP line-of-sight errors and improve support for attack operations;
- Complete SBIRS/JTAGS study on joint common multi-mission mobile processor;
- Develop and demonstrate fusion and processing of other intelligence data using SHIELD and transfer capability to ALERT;
- Perform risk reduction efforts for the SBIRS using SHIELD;
- Field JTAGS units;
- Complete the rehost of the Composite Tactical Display/Generic Area Limitation Environment to an SGI platform using SHIELD;
- Conduct experiments on TACDAR auto-release messages to ALERT;
- Investigate and implement TACDAR and ALERT message consolidation.

Work planned for FY 1998:

- Complete SHIELD/ALERT test and evaluation activities;
- Continue risk reduction efforts for the SBIRS SHIELD.
- Implement TACDAR auto-release messages to ALERT first increment;
- Complete implementation of TACDAR and ALERT message consolidation;
- ALERT Full Operational Capability (FOC) on October 1, 1997.

2.8.3.2 Sensor Cueing

Sensor cueing enhances the detection of targets by fire control radar systems. This enhancement results in reduced radar loading and extended target acquisition range. Radar loading is reduced during TBM detection and tracking by decreasing the radar's search volume. Extending the target acquisition range permits the radar to increase its defended area footprints. This increase in range is particularly important in non-benign environments, i.e., multi-target, electronic countermeasures, and inclement weather. Additionally, resulting enhanced beam scheduling improves target acquisition in non-benign environments while reducing the system's vulnerability to saturation raids and to anti-radiation missiles.

Sensor cueing efforts include development of software to accept cues into current systems and tactical cueing and netting demonstrations. TMD weapon systems, such as PATRIOT or THAAD, are cued by other tactical systems and sensors such as JTAGS/ALERT, TPS-75, SPY-1, or TPS-59. Other sensor efforts include tactical processing and application of space sensor data in the ALERT project and airborne sensor technology development. Sensor cueing efforts provided operational PATRIOT cueing software during FY 1996. In FY 1997, the cueing demonstrations will transition to the CINCs' TMD Assessment Program.

2.9 Acquisition Programs

The TMD acquisition programs include the core programs, Corps SAM/MEADS, and the Air Force's ABL. The following sections discuss the status of the TMD acquisition programs.

2.9.1 Introduction to TMD Core Programs

In FY 1996 there were three core programs: the PATRIOT Advanced Capability-3 (PAC-3), the Navy Area Theater Ballistic Missile Defense, and the Theater High Altitude Area Defense (THAAD) System. The first two are improvements to existing air defense systems which will significantly enhance lower-tier ballistic missile defense. The third program includes a new missile, a new radar, and associated BM/C^{4}I to provide an upper-tier capability. Beginning in FY 1997, BMDO moved Navy Theater Wide TBMD into the core programs. The four core programs will significantly enhance the U.S. TMD capability.

The PAC-3 System will incorporate a new, highly lethal hit-to-kill interceptor and improvements to the PATRIOT ground radar, launcher, and communication systems.

The Navy Area TBMD Program adds TBM capability to the STANDARD Missile while maintaining its capability against antiship cruise missiles by making changes to its blast fragmentation warhead and guidance system. It also includes improvements to the AEGIS Weapon System (AWS), AN/SPY-1 radar, the Weapon Control System, and the Command and Decision System.

The THAAD System incorporates a new hit-to-kill missile and radar and a new BM/C^{4}I system. THAAD will provide a capability to engage ballistic missiles at longer ranges and at higher altitudes than the other two systems, thus providing the combat commander with a two-tiered defense that will allow for multiple engagements of incoming missiles with systems that possess different capabilities.

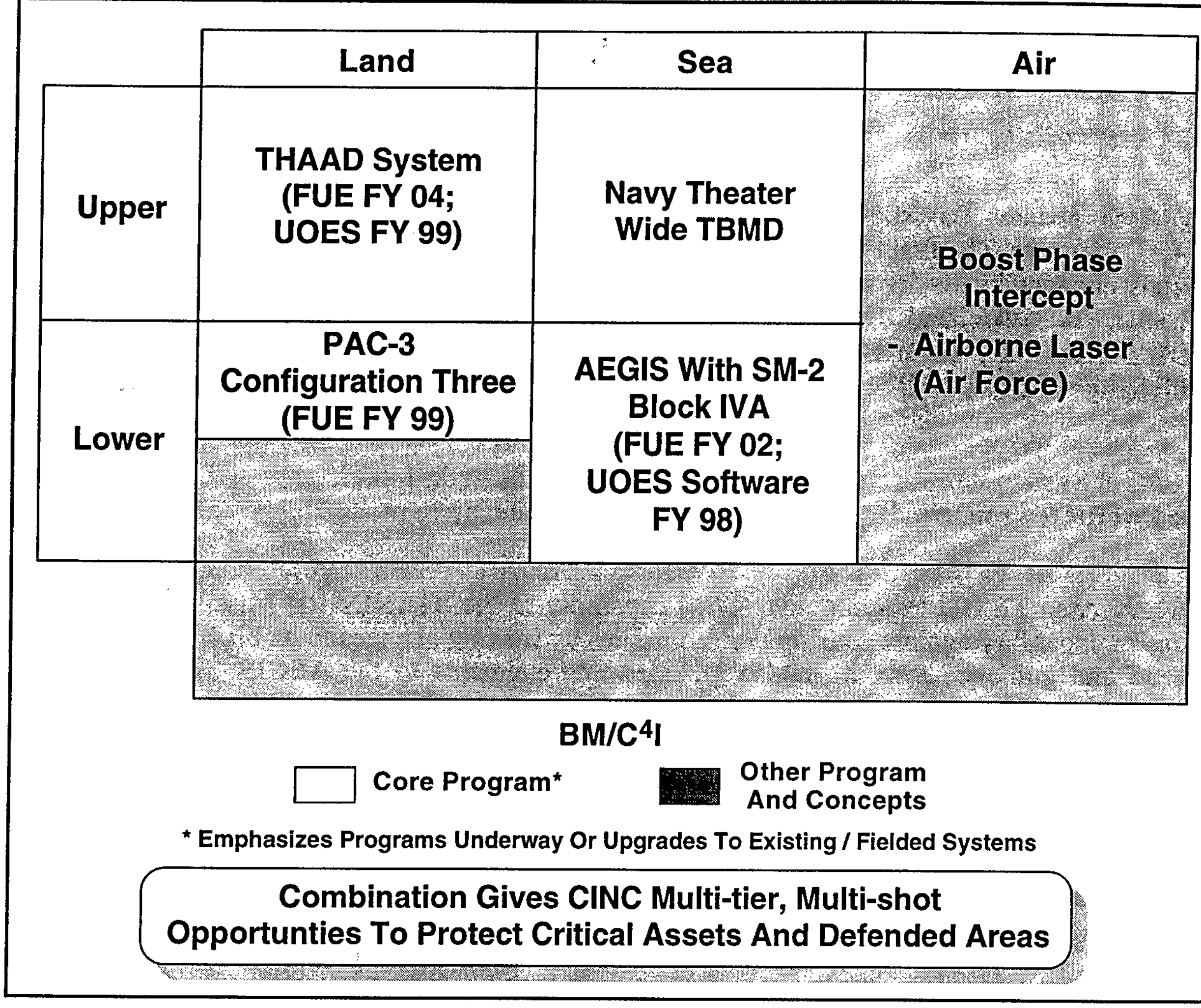
The Navy Theater Wide TBMD Program will build on the AEGIS infrastructure by evolving the Navy's Area TBMD capability through combat system improvements and development of an interceptor with an exoatmospheric capability.

The combination of the four core systems working autonomously or in unison will greatly enhance the probability of destroying incoming missiles before they can affect the critical assets in a theater of operations. Figure 2-11 shows the core programs inserted into the TMD active defense framework. The following sections discuss the status of the core programs.

2.9.1.1 Phased Array Tracking to Intercept Of Target (PATRIOT) Advanced Capability-3 (PAC-3)

The PAC-3 program will increase system battlespace and lethality capabilities through a series of upgrades to the PATRIOT ground system and through the use of the new PAC-3 missile (previously called Extended Range Intercept Technology (ERINT)). Planned radar enhancements will increase detection range; improve target classification, discrimination, and identification; improve the engagement of targets with reduced radar signatures; increase target handling capability; increase firepower; and enhance survivability. Planned launcher enhancements will increase

Figure 2-11. TMD Active Defense Framework-Core Programs



remote launcher capability, thus extending the battlespace. PAC-3 is designed to counter aircraft, tactical ballistic missiles, and cruise missiles.

The PAC-3 upgrades will be implemented through a series of fielded configurations. Configuration One consists of an expanded weapons control computer, optical disk, embedded data recorder, and pulse doppler processor. Software associated with these hardware improvements along with other software improvements will be fielded as part of Configuration One, which had its FUE in FY 1996.

Configuration Two consists of Communications Enhancements Phase I; two software improvements – the counter anti-radiation missile and Classification, Discrimination and Identification (CDI) Phase I; and implementation, via software, of the full capability of the Radar Enhancements Phase II hardware (the pulse doppler processor fielded in Configuration One). Configuration Two will be implemented by the Post Deployment Build-4 software and had its FUE in early FY 1997.

Configuration Three consists of seven major improvements. Four of them are hardware improvements: the PAC-3 missile, Radar Enhancements Phase III, CDI Phase III, and Remote Launch/Communications Enhancements Upgrade Phase III. The three software upgrades consist of PATRIOT/THAAD Interoperability, Joint TMD Interoperability, and Launch Point Determination. Configuration Three will be implemented by Post Deployment Build-5 software and will have its FUE in late FY 1999.

In the second quarter of FY 1994, the Army selected the ERINT missile for the PAC-3 Program. An independent review of the ERINT selection performed by OSD prior to the PAC-3 Defense Acquisition Board (DAB) supported the Army decision. ERINT is a hit-to-kill interceptor that provides active defense against TBMs and air breathing threats. It uses an onboard active Ka-band seeker, aerodynamic control vanes, and impulse attitude control thrusters to provide the rapid maneuvering necessary for a hit-to-kill intercept. Hit-to-kill technology, as opposed to blast fragmentation, will increase lethality against WMD.

The Dem/Val flight test program, which consisted of two controlled test flights and four guided test flights, successfully demonstrated the PAC-3 missile's hit-to-kill capability against a low altitude air breathing target and ballistic tactical target vehicles with simulated chemical submunitions and bulk chemical warheads.

Developmental and operational test and evaluation will start in FY 1997 and be completed in the third quarter of FY 1999. PAC-3 missile fielding will begin in the fourth quarter of FY 1999.

The following tables provide information specified in the Conference Report, Section 234(e)(1) and (2), accompanying S. 1124, the National Defense Authorization Act for Fiscal Year 1996. This requirement calls for "a description of technical milestones, the schedule, and the cost of each phase...for each TMD acquisition program." The requirement also asks for a description of the variances in the technical milestones, program schedule milestones, and costs compared to both (1) the report submitted the previous year, and (2) the report submitted the first (initial) year. Information based on the FY 1997 President's Budget will be considered the "initial" and "previous" estimate while the FY 1998 President's Budget will serve as the basis for the "current" estimate. Tables 2-1A, 2-1B, and 2-1C provide information on the PATRIOT PAC-3 Program.

FY 1996 efforts resulted in the following accomplishments:

- PAC-3 EMD program was restructured to add schedule and resources to the program to reduce program risk and ensure a successful FUE in the fourth quarter of FY 1999;
- Obtained full materiel release on Configuration One; five of ten U.S. battalions modified;
- Conducted Critical Design Review (CDR) and Initial Production Readiness Reviews of the PAC-3 missile;
- Continued Radar Phase III modification kit procurement and conducted LPA demo for CDI Phase III and Remote Launch/Communication Enhancements Upgrade kit procurement;

Table 2-1A. PAC-3 Program Cost Summary

	Total Previous Years (TY)	FY 97	FY 98	FY 99	FY 00	FY 01	FY 02	FY 03	To Complete	Total (TY)	Total (BY)	Previous Year Total (BY)
RDT&E	1,845	381	206	101	0	0	0	0	0	2,533		
Proc	758	219	351	357	462	448	435	398	462	3,905		
MILCON	1	0	0	0	0	0	0	0	0	1		
Cost	2,604	600	557	473	462	448	435	398	462	6,439		

Explanation Of Variance From Previous:

- Transfer Of Procurement Funds To Army Beginning In FY 1998.
- $1,349M In FY 96 MILCON To Support Construction Of New MAB Facility At WSMR.

Table 2-1B. PAC-3 Program Milestones

Program Schedule Milestones	Current Estimate	Previous Estimate	Initial Estimate	Explanation Of Variance From Previous
Milestone I - Dem / Val				
• Contract Award				
• System Requirements Review				
• System Design Review				
• Development Test				
Milestone II - EMD				
• Contract Award	1Q FY 95	1Q FY 95	1Q FY 95	
• Preliminary Design Review	4Q FY 95	4Q FY 95	4Q FY 95	
• Critical Design Review	2Q FY 96	2Q FY 96	2Q FY 96	
Milestone III - Production				
• LRIP Contract Award	2Q FY 98	2Q FY 98	2Q FY 98	
• First Unit Equipped (FUE)	4Q FY 99	4Q FY 99	4Q FY 99	
• FRP Contract Award	1Q FY 00	1Q FY 00	1Q FY 00	

Table 2-1C. PAC-3 Technical Milestones

Technical Milestones	Current Estimate	Previous Estimate	Initial Estimate	Explanation Of Variance From Previous
Milestone I - Dem / Val				
• Developmental Test				
Milestone II - EMD				
• Development Test Start	3Q FY 97	3Q FY 97	3Q FY 97	
• Operational Test Start	2Q FY 99	2Q FY 99	2Q FY 99	
• System Integration Test	4Q FY 98	4Q FY 98	4Q FY 98	
Milestone III - Production				
• MSE Start	4Q FY 98	4Q FY 98	4Q FY 98	

- Continued TMD/THAAD integration and cueing software program to provide the basis for interoperability within TMD via JTIDS TADIL-J messages to the THAAD battery tactical operations center;
- Continued Live Fire Testing and Evaluation (LFT&E) testing;
- Participated in Mountain Top Cruise Missile Defense Advanced Concept Technology Demonstration (ACTD);
- Conducted Configuration Two contractor development test and evaluation, force development test and experimentation, and follow-on operational test and evaluation;
- Continued PAC-3 EMD target and test support and risk reduction and mitigation efforts;
- Provided resources for PAC-3 missile assembly building modification.

Work planned for FY 1997:

- Field first Configuration Two-equipped PATRIOT unit;
- Continue PAC-3 missile EMD program with formal flight testing, target and test support, LFT&E effort, and risk reduction and mitigation efforts;
- Continue Radar Phase III modification kit procurement;
- Conduct CDI Phase III PQT, and initiate modification kit procurement;
- Conduct Remote Launch/Communications Enhancement Upgrade PQT;
- Initiate limited procurement of Enhanced Launcher Electronics System and fire solution computer, and Remote Launch/Communications Enhancements Upgrade modification kits.

Work planned for FY 1998:

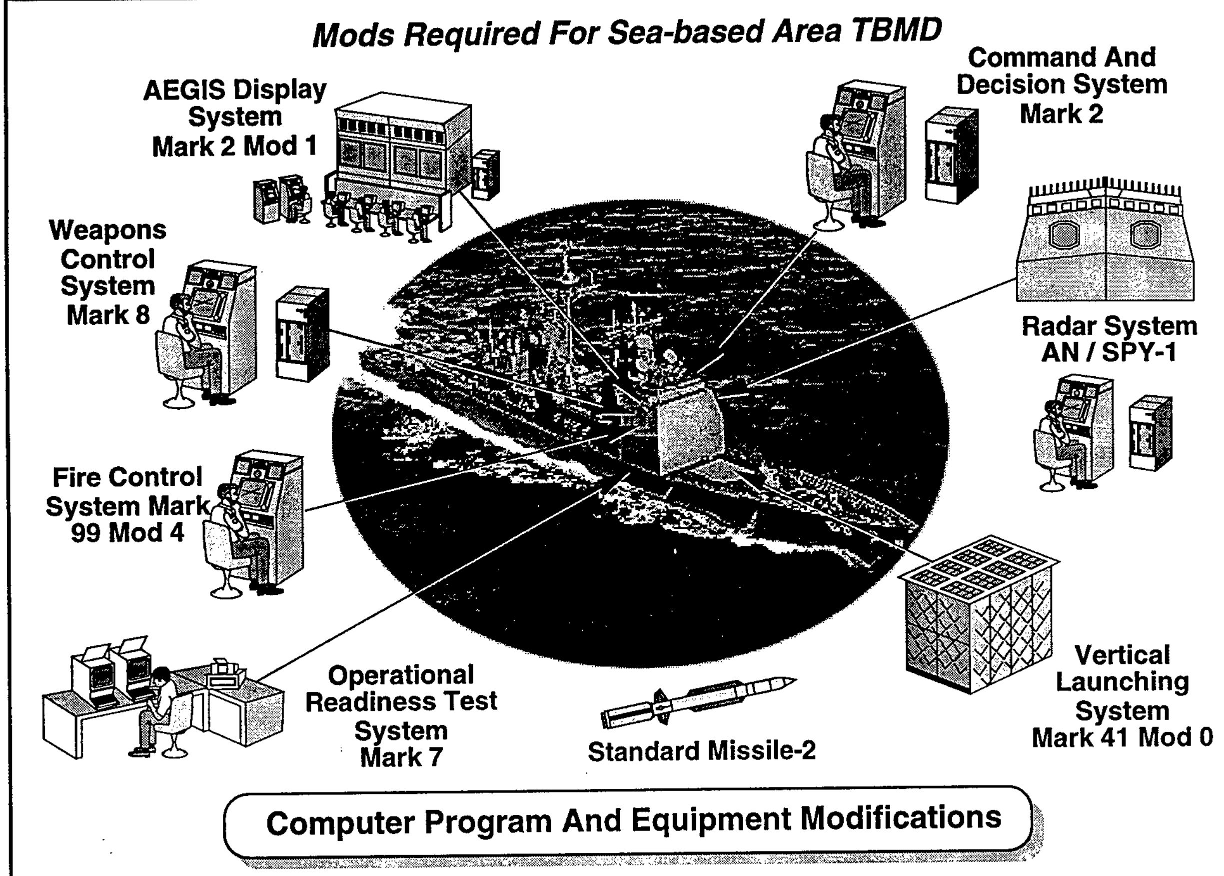
- Obtain PAC-3 missile Low Rate Initial Production (LRIP) approval;
- Initiate LRIP of the PAC-3 missile;
- Continue PAC-3 EMD missile flight test program, target and test support, LFT&E testing, and risk mitigation efforts;
- Continue Radar Phase III, CDI Phase III, and Remote Launch/Communications Enhancements modification kit procurement;
- Conduct Configuration Three contractor development test and evaluation, and force development test and experimentation.

2.9.1.2 Navy Area TBMD

The goal of the Navy Area TBMD program is to provide a sea-based TBMD capability by build-

ing on the existing AWS. The program will focus on (1) modifying AWS, including the Vertical Launch System (VLS), to enable TBM detection, tracking, and engagement, and (2) improving the STANDARD Missile-2 Block IV (SM-2 Block IV) seeker, autopilot, fuze, and warhead. Figure 2-12 highlights the modifications required for each element of the AWS; Figure 2-13 highlights the modified SM-2 Block IV (designated SM-2 Block IVA).

Figure 2-12. AEGIS Weapon System

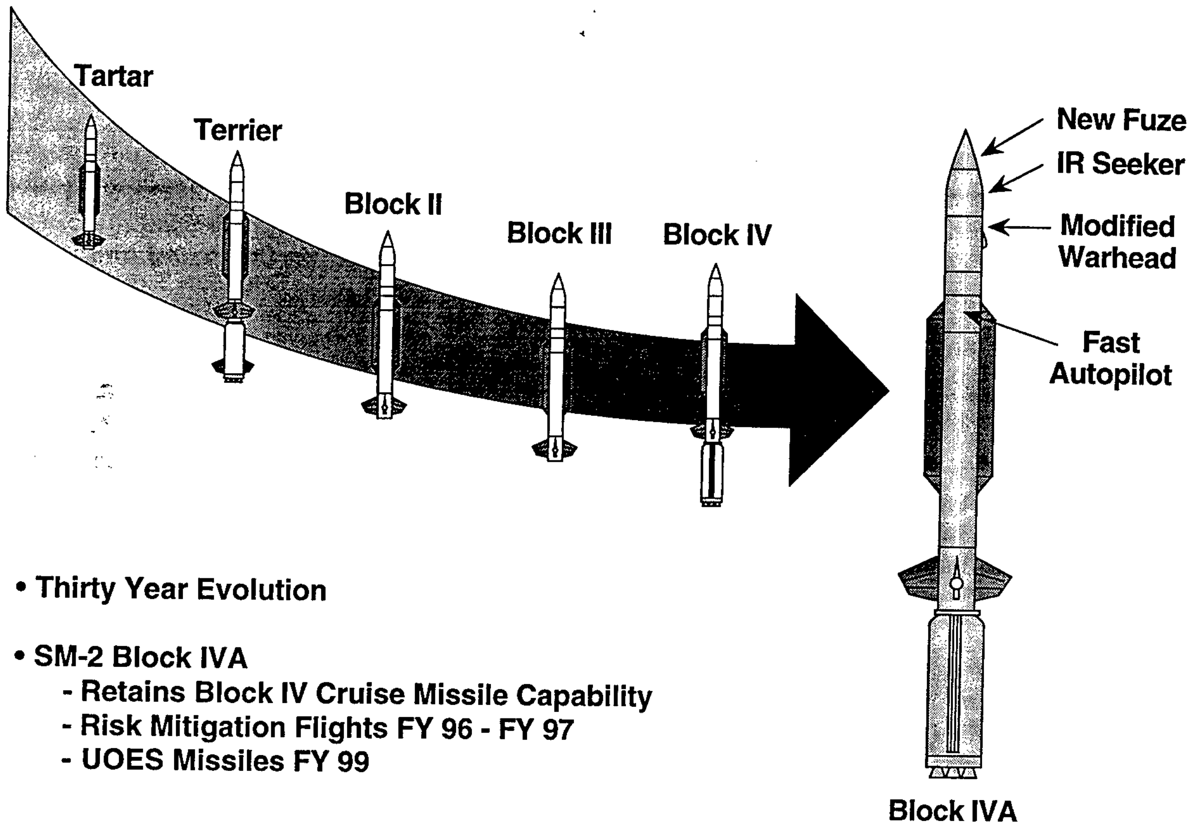


The AN/SPY-1 radar computer programs and equipment will be modified to allow search at higher elevations and longer ranges to detect and track ballistic targets while maintaining an Anti-Air Warfare (AAW) capability. The modified AWS will be able to predict intercept points and engagement boundaries for ballistic targets, initialize missiles, conduct firings, and provide uplink commands as the missile flies to intercept a TBM.

AEGIS displays and onboard command and decision system computer programs and equipment will be modified to display TBM tracks and engagements and to interface with other elements of the combat system, as well as with off-ship sensors (e.g., DSP).

The following changes to the baseline SM-2 Block IV will improve intercept performance against ballistic missiles within the atmosphere:

Figure 2-13. STANDARD Missile-2 Modifications



- **Thirty Year Evolution**
- **SM-2 Block IVA**
  - **Retains Block IV Cruise Missile Capability**
  - **Risk Mitigation Flights FY 96 - FY 97**
  - **UOES Missiles FY 99**

- An infrared seeker will increase the probability of direct hits;
- Autopilot modifications will improve missile maneuverability;
- Fuze improvements will increase lethality in high closing rate missile-to-missile encounters; and
- Warhead modifications will improve lethality against TBMD and AAW targets by capitalizing on engineering analysis and design efforts already completed for the PATRIOT missile.

The test and evaluation program for Navy Area TBMD is an outgrowth of over 20 years of computer program development and management, missile development, and AWS engineering. It includes early missile hardware integration and flight test, infrared seeker wind tunnel and sled testing, warhead development using lessons learned from PATRIOT, early at-sea testing of prototypical computer programs, and extensive land-based development of AWS computer programs and equipment at the Combat System Engineering Development (CSED) site in Moorestown, New Jersey.

A successful at-sea experiment was conducted in June 1995 to demonstrate the extended tracking capability of the AEGIS Combat System (ACS) and SPY-1 radar acquisition, and the use of off-

ship cueing sources. The objectives of the experiment were to: (1) demonstrate SPY-1 radar ability to detect and track a TBM; (2) demonstrate the ability of the AWS to receive a national or remote TBM cue and initiate TBM search, proving TRE interface with AWS and TBM message processing; (3) demonstrate the ability of AWS to support multiunit coordinated TBMD operations through the exchange of TBM data via tactical data links; (4) gather engineering data to support continuing systems design studies to optimize anti-air warfare system and TBMD capabilities; and (5) gather data to support discrimination algorithm studies. This non-firing exercise employed two AEGIS class cruisers to detect and track one dedicated TBM target. Cueing by a space-based warning system or remote sensors and ship-to-ship cueing and data exchange was demonstrated. The test occurred at the Pacific Missile Range Facility (PMRF), Barking Sands, Hawaii, using a Sandia National Laboratories STRYPI IX missile. All of the test objectives were successfully completed.

The SM-2 Block IV successfully completed an operational assessment and commenced LRIP in FY 1995. This missile upgrade is the basis for the initial sea-based TBMD capability that focuses on the more numerous, shorter-range, lower-apogee threats. Future efforts will focus on improving the guidance of the Block IVA to effect increased lethality against emerging threats including chemical submunitions and other WMD. The August 1994 DAB review of Navy TBMD endorsed this evolutionary approach and approved risk reduction activities leading to a Milestone II DAB review in FY 1997.

A series of progressively challenging flight tests using SM-2 IR Seeker Risk Reduction missiles is currently underway at White Sands Missile Range (WSMR). An Engineering Test Round (ETR), successfully flown in August 1996, demonstrated missile functionality and verified aero-thermal models. Three Development Test Rounds (DTR) tests are planned against TBM representative targets. DTR-1a, successfully flown at WSMR in January 1997, demonstrated infrared seeker functionality and missile lethality with a fragmentation warhead against a Lance target, thereby completing a critical exit criteria that led to a Milestone II decision in February 1997 to proceed to EMD.

In addition to the early risk reduction test rounds, 13 missiles (including three inert operational missiles) will be procured for developmental testing at WSMR. During early EMD, two AEGIS cruisers will receive the initial version of the TBMD software, along with minor hardware upgrades, providing a UOES for user feedback during the development process. This interim system will provide the opportunity to evaluate organizational and doctrinal concepts in support of the follow-on tactical capability. In FY 1999, the initial missiles from the lot of 35 missiles procured for Technical and Operational Evaluation (TECHEVAL and OPEVAL) (beginning in FY 2001) will be delivered and could be made available for use by the two UOES cruisers. Based on a predetermined schedule, these missiles will be used in the 25 TECHEVAL and OPEVAL flight tests. The remaining missiles will constitute the UOES inventory, which will provide an interim TBMD capability prior to the installation of tactical software and hardware upgrades in 79 AEGIS Cruisers and Destroyers, and the initial delivery of LRIP missiles beginning in FY 2001.

The following tables provide information specified in the Conference Report, Section 234(e)(1) and (2), accompanying S. 1124, the National Defense Authorization Act for Fiscal Year 1996. This requirement calls for "a description of technical milestones, the schedule, and the cost of each phase...for each TMD acquisition program." The requirement also asks for a description of the variances in the technical milestones, program schedule milestones, and costs compared to both (1) the report submitted the previous year, and (2) the report submitted the first (initial) year.

Information based on the FY 1997 President's Budget will be considered the "initial" and "previous" estimate while the FY 1998 President's Budget will serve as the basis for the "current" estimate. Tables 2-2A, 2-2B, and 2-2C provide information on the Navy Area TBMD Program.

FY 1996 efforts resulted in the following accomplishments:

- Continued AEGIS computer program and equipment development;
- Conducted AWS UOES TBMD Preliminary Design Review (PDR);
- Developed design specifications;
- Continued detailed missile design and conducted PDR;
- Commenced risk reduction flight tests at WSMR to resolve issues of aero-thermal blur, infrared seeker performance, infrared cover survivability, and model simulation;
- Continued command and control processor development and implementation of TBMD messages on LINK-11 and LINK-16;
- Commenced procurement of AWS modifications for ships and development sites and support and training equipment for shore facilities.

Work planned for FY 1997:

- Complete risk reduction flight tests at WSMR to resolve issues of aero-thermal blur, infrared seeker performance, infrared cover survivability, and model simulation;
- Continue development of tactical computer program, start development of computer program design specification, and conduct system design and PDR;
- Commence missile engineering and manufacturing development, conduct CDR, complete detailed missile design, initiate fabrication of UOES/WSMR missiles, initiate procurement of Developmental Test and Operational Test (DT/OT) flight test missiles;
- Continue systems engineering and analysis;
- Procure test targets and conduct test planning;
- Define interface for TBMD-related upgrades to AEGIS and Joint Maritime Command Information System (JMCIS);
- Continue command and control processor development;
- Procure AWS modifications for ships and development sites and support and training equipment for shore facilities.

Work planned for FY 1998:

- Deliver AEGIS UOES computer program, conduct CDR for tactical program, and initiate tactical program testing at CSED site;
- Deliver WSMR development test missiles;

Table 2-2A. Navy Area TBMD Program Cost Summary

	Total Previous Years (TY)	FY 97	FY 98	FY 99	FY 00	FY 01	FY 02	FY 03	To Complete	Total (TY)	Total (BY)	Previous Year Total (BY)
RDT&E	633	301	268	227	222	159	52	38	154	2,054		
Proc	30	9	15	45	130	161	236	225	805	1,656		
MILCON	0	0	0	0	0	0	0	0	0	0		
Cost	663	310	283	272	352	320	288	263	959	3,710		

Explanation Of Variance From Previous:

- Transfer Of Procurement Funds To Navy Beginning In FY 1998.

Table 2-2B. Navy Area TBMD Program Milestones

Program Schedule Milestones	Current Estimate	Previous Estimate	Initial Estimate	Explanation Of Variance From Previous
Milestone I - Dem / Val	N/A			
• Contract Award				
• System Requirements Review				
• System Design Review				
• Development Test				
Milestone II - EMD				
• Contract Award	2Q FY 97	4Q FY 96	4Q FY 96	ETR And DTR-1 No Tests Caused Extensive Delays
• Preliminary Design Review	2Q FY 97	4Q FY 96	4Q FY 96	
• Critical Design Review	3Q FY 97	3Q FY 96	3Q FY 96	
- Missile	2Q FY 97	4Q FY 96	4Q FY 96	
• Critical Design Review - AEGIS Tactical	2Q FY 98	3Q FY 97	3Q FY 97	
Milestone III - Production	2Q FY 02	2Q FY 01	2Q FY 01	Flight Test Delays
• LRIP Contract Award	2Q FY 01	3Q FY 01	3Q FY 01	
• First Unit Equipped (FUE)	1Q FY 02	2Q FY 02	2Q FY 02	
• FRP Contract Award	3Q FY 02	2Q FY 01	2Q FY 01	

Table 2-2C. Navy Area TBMD Technical Milestones

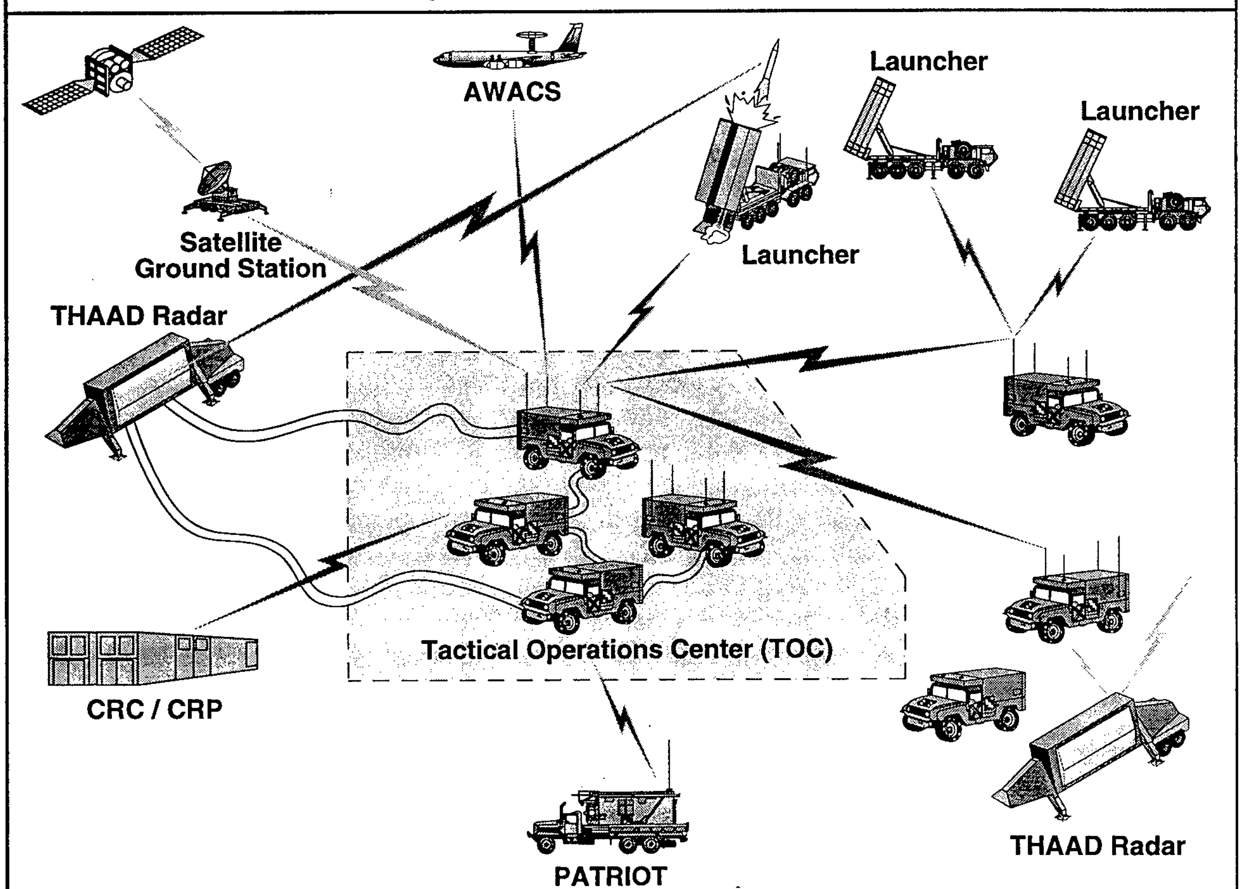
Technical Milestones	Current Estimate	Previous Estimate	Initial Estimate	Explanation Of Variance From Previous
Milestone I - Dem / Val	N/A			
• Developmental Test				
Milestone II - EMD	2Q FY 97	4Q FY 96	4Q FY 96	Flight Test Delays
• Development Test Start - Land Based	4Q FY 99	2Q FY 00	2Q FY 00	Adjustment Of Test Plans
• Developmental Test Start - Sea Based	3Q FY 01	2Q FY 01	2Q FY 01	Reevaluation Of UOES Requirements
• Operational Test Start	4Q FY 01	2Q FY 01	2Q FY 01	
Milestone III - Production - MSE Start	2Q FY 02	2Q FY 02	2Q FY 02	

- Initiate fabrication of at-sea development and operational test missiles;
- Continue systems engineering and analysis;
- Continue implementation of JMCIS TBMD segments and TBMD messages in the command and control processor;
- Commence upgrades at PMRF to support DT/OT;
- Continue AWS modifications procurement for ships.

2.9.1.3 The Theater High Altitude Area Defense (THAAD) System

The THAAD system, shown in Figure 2-14, is being developed to negate theater ballistic missiles at long range and high altitudes. Its long-range intercept capability will protect broad areas, dispersed assets, and population centers against TBM attacks. The THAAD system includes radars, BM/C^{4}I units, missiles, launchers, and support equipment. The THAAD radar provides threat early warning, threat type classification, interceptor fire control, external sensor cueing, launch and impact point estimates for the THAAD system. The THAAD radar is based on state-of-the-art, solid-state, X-band radar technologies. THAAD will be interoperable with both existing and future air defense systems. This netted and distributed BM/C^{4}I architecture will provide robust protection across the TBM threat spectrum. THAAD is pursing integration of THAAD BM/C^{4}I

Figure 2-14. The THAAD System



with the Project Manager, Air Defense Command and Control System, to take advantage of previous Army developments that can be incorporated into the THAAD program.

The THAAD missile is a single-stage, solid-fuel missile employing thrust vector technology and a divert and attitude control system. Predicted intercept point and guidance presets are provided by the THAAD radar to the missile prior to launch. The THAAD missile receives in-flight updates including a target object map for target designation. Terminal guidance data is provided by an infrared seeker looking through a side-mounted, uncooled window. The seeker window is protected by a shroud that separates prior to terminal homing. The THAAD missile kill vehicle exhibits enhanced lethality by destroying incoming warheads utilizing kinetic energy impact (hit-to-kill). It is capable of both endoatmospheric and exoatmospheric intercepts.

The THAAD launcher contains a missile-round pallet mounted on a modified U.S. Army Palletized Loading System (PLS) truck. Primary power to the launcher is supplied by lead acid batteries that are automatically recharged by a quiet tactical generator. Launch position is determined by the global positioning system and the launch azimuth by a direction reference unit.

The PD/RR program (formerly referred to as Dem/Val) will develop a design for the objective THAAD system and demonstrate the capabilities of the system in a series of flight tests. The residual hardware resulting from the THAAD PD/RR program, including the UOES option, will be used for a prototype UOES system. The UOES, used primarily for early operational assessment, will also be available for limited use as a contingency capability during a national emergency. The UOES is projected to consist of 40 missiles with 4 launchers, 2 BM/C^4I units, 2 radars, and support equipment. The objective system design will be developed and tested in the EMD phase and will lead to LRIP and subsequent fielding in FY 2004.

The PD/RR flight test program will be continuing at WSMR during FY 1997. The flight test schedule consists of 11 flight and system tests. The PD/RR flight test program has been revised from 14 to 11 flights in order to allow greater time for data analysis between tests, while still collecting all data required to meet the Milestone II exit criteria. The first 9 PD/RR flights support the Milestone decision and the two additional flight tests will serve as backup tests.

THAAD's first flight occurred on April 21, 1995. This test successfully demonstrated the correct operation of the THAAD missile propulsion system, booster/kill vehicle separation, seeker shroud cover deployment, collection of seeker data, uplink/downlink communications for the WSMR Radar Interface Unit to the missile, and preplanned command destruct of the missile. The second flight occurred on July 31, 1995 and, like the first flight, was not a planned intercept attempt and did not include a target. Objectives accomplished during this test included execution of the THAAD Energy Management Steering (TEMS) maneuver, booster/kill vehicle separation, and execution of midcourse guidance maneuvers based on information from the surrogate radar. Because the missile flare did not deploy, the missile was moving faster and higher than its planned course. Missile software plotted a new fly out trajectory to achieve intercept of a simulated target trajectory, but the flight had to be terminated earlier than planned due to range safety concerns.

The third flight test was the first to involve a target missile, but was an intentional flyby in order to characterize the seeker. This test achieved its objectives and also verified the corrective actions taken as a result of flight test 2. Flight tests 4, 5, and 6 were all unsuccessful attempts to intercept

a target. Flight 4 (December 13, 1995) achieved a significant portion of its objectives, but a software error in the avionics processor caused the missile to perform an errant maneuver during flyout. Though the missile performed a significant midcourse correction and was on a path to intercept the target, it depleted its divert and attitude control system fuel just prior to intercept. An intercept was not achieved, but the missile seeker did acquire, track, and designate the target and the THAAD radar successfully participated in shadow mode. During flight test 5 (March 22, 1996), the missile failed to execute in-flight commands following booster separation. The problem was traced back to an anomalous short circuit during faulty booster separation. This served to reset the avionics processor to prelaunch status and, as a result, the missile continued on a ballistic trajectory until destroyed by range safety. Flight test 6 (July 15, 1996) verified corrective action taken after flight test 5 and represented the best overall performance of the THAAD system, but did not achieve intercept due to a seeker anomaly which caused half of the focal plane array to become inoperative. The failure investigation determined the most likely cause was contamination. Flight tests 5 and 6 did successfully demonstrate operation of the THAAD radar in shadow mode.

Flight Test 7 (FT-7) was conducted on March 6, 1997, at White Sands Missile Range. Although a body-to-body intercept was not achieved, the launcher, radar, and BM/C^3I segments all performed nominally and several important mission criteria were met. Preliminary findings indicate that the Divert and Attitude Control System (DACS) or a component of the DACS malfunctioned. Investigators have created a fault tree and are focusing on the DACS valves or valve drivers. Test personnel are conducting simulations of Flight Test-7 to possibly duplicate the test result and discover the exact cause.

The EMD phase of the THAAD Program will begin in FY 1998 with completion of the Milestone II DAB review and award of the EMD contract.

The following tables provide information specified in the Conference Report, Section 234(e)(1) and (2), accompanying S. 1124, the National Defense Authorization Act for Fiscal Year 1996. This requirement calls for "a description of technical milestones, the schedule, and the cost of each phase...for each TMD acquisition program." The requirement also asks for a description of the variances in the technical milestones, program schedule milestones, and costs compared to both (1) the report submitted the previous year, and (2) the report submitted the first (initial) year. Information based on the FY 1997 President's Budget will be considered the "initial" and "previous" estimate while the FY 1998 President's Budget will serve as the basis for the "current" estimate. Tables 2-3A, 2-3B, and 2-3C provide information on the THAAD Program.

FY 1996 efforts resulted in the following accomplishments:

- Completed missile flight test program and began system flight test program with BM/C^4I THAAD radar, and PLS launcher;
- Continued THAAD system ground testing to mitigate flight test risk;
- Continued lethality simulation code validation, hit-to-kill lethality analysis, system threat assessment, nuclear environment survivability analysis, and hit assessment, discrimination, and guidance, navigation and control algorithm development;

Table 2-3A. THAAD Program Cost Summary

	Total Previous Years (TY)	FY 97	FY 98	FY 99	FY 00	FY 01	FY 02	FY 03	To Complete	Total (TY)	Total (BY)	Previous Year Total (BY)
RDT&E	2,444	619	556	595	603	585	414	373	179	6,368		
Proc	0	0	0	0	0	34	534	608	5,247	6,423		
MILCON	13	0	5	0	0	0	0	5	0	23		
Cost	2,457	619	561	595	603	619	948	986	5,426	12,814		

Explanation Of Variance From Previous:

- DoD Added $722M To RDT&E And Removed Procurement Funding
- Procurement Funding Transferred To The Services Beginning In FY 1998

Table 2-3B. THAAD Program Milestones

Program Schedule Milestones	Current Estimate	Previous Estimate	Initial Estimate	Explanation Of Variance From Previous
Milestone I - Dem / Val	2Q FY 92		2Q FY 92	
• Contract Award	4Q FY 92		4Q FY 92	
• System Requirements Review	2Q FY 95		2Q FY 95	
• System Design Review	3Q FY 96		3Q FY 96	
• Development Test	3Q FY 95		3Q FY 95	
Milestone II - EMD	2Q FY 98		2Q FY 97	PD / RR Flight Test Delays
• Contract Award	2Q FY 98		3Q FY 97	PD / RR Flight Test Delays
• Preliminary Design Review	4Q FY 98		2Q FY 98	PD / RR Flight Test Delays
• Critical Design Review	4Q FY 00		2Q FY 99	PD / RR Flight Test Delays
Milestone III - Production	4Q FY 04		4Q FY 04	
• LRIP Contract Award	2Q FY 02		1Q FY 03	PBD 224 Accelerates FUE To FY 04
• First Unit Equipped (FUE)	4Q FY 04		2Q FY 06	PBD 224 Accelerates FUE To FY 04
• FRP Contract Award	1Q FY 05		2Q FY 05	PBD 224 Accelerates FUE To FY 04

Table 2-3C. THAAD Technical Milestones

Technical Milestones	Current Estimate	Previous Estimate	Initial Estimate	Explanation Of Variance From Previous
Milestone I - Dem / Val				
• Developmental Test	3Q FY 95		3Q FY 95	
Milestone II - EMD				
• Development Test Start	4Q FY 00		4Q FY 00	
• Operational Test Start	2Q FY 02		2Q FY 02	
Milestone III - Production				
• FUE	4Q FY 04		2Q FY 06	PBD 224 Accelerates FUE To FY 04

- Conducted System Design Review (SDR);
- Completed factory string tests on UOES radars and fabrication and integration of UOES radars and delivery to WSMR;
- Continued integration and testing of JTIDS, launch support, BM/C^4I, weapon system deck model, and simulation efforts;
- Maintained integrated logistics and product assurance efforts.

Work planned for FY 1997:

- Exercise UOES missile option;
- Conduct Software Specification Review and SDR update;
- Conduct radar characterization tests at WSMR and the United States Army Kwajalein Atoll (USAKA) in conjunction with Theater Critical Measurements Program (TCMP-2);
- Continue system flight test program;
- Begin radar Monolithic Microwave Integrated Circuit producibility and yield improvements for EMD;
- Continue nuclear environment survivability analysis;
- Continue hit assessment, discrimination, and guidance, navigation and control algorithm development, hit-to-kill lethality analysis, and system threat assessment;
- Continue integration and testing of JTIDS, launch support, BM/C^4I, weapon system deck model, and simulation efforts.

Work planned for FY 1998:

- Conduct Milestone II DAB review;
- Award EMD Contract;
- Begin software maintenance;
- Continue radar Monolithic Microwave Integrated Circuit producibility and yield improvements for EMD;
- Continue objective system design engineering, software independent verification and validation, nuclear environment survivability analysis, hit assessment, discrimination, and guidance, navigation and control algorithm development, hit-to-kill lethality analysis, and system threat assessment;
- Continue integration and testing of JTIDS, launch support, BM/C^4I, weapon system deck model, and simulation efforts;
- Conduct Limited User Test.

2.9.1.4 Navy Theater Wide Theater Ballistic Missile Defense (TBMD)

The Navy Theater Wide (NTW) TBMD Program will provide an upper-tier, sea-based capability to counter medium- to long-range TBM threats. The program builds on the existing AWS and STANDARD Missile infrastructure as a further evolution to the Navy Area TBMD System. The AWS will be modified to support exoatmospheric ascent and descent phase engagements. The STANDARD Missile Block IV will be modified to include a third stage rocket motor and fourth stage Lightweight Exoatmospheric Projectile (LEAP) kinetic warhead utilizing an infrared seeker.

The current NTW program is consistent with the direction of last year's BMD Program Review. This program consisted of three parallel efforts. The first of these efforts is a kinetic warhead technology assessment. This review is examining technologies including LEAP, THAAD, the Atmospheric Interceptor Technology (AIT) program, and the Exoatmospheric Kill Vehicle (EKV) program. This review will ensure the Department is pursuing the appropriate kinetic warhead solution for the NTW system. The Department will make a decision on the correct approach for NTW in FY 1998.

In parallel with the technology review, BMDO and the Navy are proceeding to a system level intercept, called the NTW Flight Demonstration Program (FDP) or AEGIS LEAP Intercept (ALI). The FDP/ALI is using a derivative of the LEAP kinetic warhead used in the previous BMDO and Navy Terrier LEAP intercept attempts. This kinetic warhead will be integrated with components of the Navy STANDARD Missile-2 Block IV. The resulting theater-wide missile will be called the STANDARD Missile-3 (SM-3). The FDP/ALI flights will be conducted from an AEGIS ship at the PMRF. The Navy will modify an Area TBMD UOES ship as necessary to support the FDP/ALI flights. The current plan includes a series of eight flight tests. The first four, called Control Test Vehicles (CTVs), develop understanding of this missile through incremental testing. The second four, called Guidance Test Vehicles (GTVs), will intercept a TBM target. The first intercept will be approximately the second quarter of FY 2000.

The third portion of the NTW program is risk reduction activities. These activities will examine the critical risk areas for NTW engineering and develop solutions that will allow BMDO, at the appropriate time, to make an informed decision to enter the EMD phase. In addition, they support potential development of an early NTW initial capability (UOES). These risk areas include discrimination, lethality, propulsion, divert, kinetic warhead seeker, BM/C^{3}I, ship systems, and system engineering.

The Department has declared NTW a "core" TMD program. More significantly, the Department has also declared NTW a pre-Major Defense Acquisition Program (MDAP), a program that may eventually become an MDAP. Accordingly, BMDO and the Navy have initiated the necessary steps to establish NTW as an acquisition program in compliance with DoD 5000 requirements.

The following tables provide information specified in the Conference Report, Section 234(e)(1) and (2), accompanying S. 1124, the National Defense Authorization Act for Fiscal Year 1996. This requirement calls for "a description of technical milestones, the schedule, and the cost of each phase...for each TMD acquisition program." The requirement also asks for a description of the variances in the technical milestones, program schedule milestones, and costs compared to both (1) the report submitted the previous year, and (2) the report submitted the first (initial) year. Since this year's report constitutes the first (initial) submission, no variances will be identified or

discussed. Information based on the FY 1998 President's Budget will be considered the "initial" estimate. Tables 2-4A, 2-4B, and 2-4C provide information on the Navy Theater Wide Program.

FY 1996 efforts resulted in the following accomplishments:

- Completed the Navy TBMD COEA Phase I;
- Conducted system and design engineering to support the FDP/ALI flight tests;
- Conducted initial lethality tests for NTW;
- Started the Navy TBMD COEA Phase II to confirm the NTW material alternative.

Work Planned for FY 1997:

- Continue system engineering for the FDP/ALI flight tests;
- Conduct Final Design Review for FDP/ALI missile (SM-3);
- Conduct first flight test (Control Test Vehicle 1);
- Continue LEAP lethality testing;
- Begin Joint Systems Engineering Team studies on kinetic kill vehicle technologies;
- Conduct test of third stage rocket motor;
- Complete Navy TBMD COEA Phase II.

Work Planned for FY 1998:

- Conduct DAB Review to complete Phase 0 activities;
- Continue system engineering for the FDP/ALI flight tests;
- Conduct AWS System Design Review for FDP/ALI;
- Conduct second ALI flight test;
- Conduct ALI target test flight;
- Conduct hover testing of the LEAP SM-3 kinetic warhead.

2.9.2 Corps SAM/Medium Extended Air Defense System (MEADS)

The Corps SAM Program was initiated to provide defense of vital corps and division assets associated with the Army and Marine Corps maneuver forces. The Corps SAM system was being developed to provide: (1) defense against multiple and simultaneous attacks by Short Range Bal-

Table 2-4A. Navy Theater Wide Program Cost Summary

	Total Previous Years (TY)	FY 97	FY 98	FY 99	FY 00	FY 01	FY 02	FY 03	To Complete	Total (TY)	Total (BY)	Previous Year Total (BY)
RDT&E	356	304	195	192	191	191	145	149	432	2,155		
Proc	0	0	0	0	0	0	0	0	0	0		
MILCON	0	0	0	0	0	0	0	0	0	0		
Cost	356	304	195	192	191	191	145	149	432	2,155		

Table 2-4B. Navy Theater Wide Program Milestones

Program Schedule Milestones	Current Estimate	Previous Estimate	Initial Estimate	Explanation Of Variance From Previous
Milestone I - Dem / Val				
• Contract Award	NA		NA	
• System Requirements Review	TBD		TBD	
• System Design Review	TBD		TBD	
• Development Test	FY 00		TBD	
Milestone II - EMD	TBD		TBD	
• Contract Award				
• Preliminary Design Review				
• Critical Design Review - Missile				
• Critical Design Review - AEGIS Tactical				
Milestone III - Production	TBD		TBD	
• LRIP Contract Award				
• First Unit Equipped (FUE)				
• FRP Contract Award				

Table 2-4C. Navy Theater Wide Technical Milestones

Technical Milestones	Current Estimate	Previous Estimate	Initial Estimate	Explanation Of Variance From Previous
Milestone I - Dem / Val	FY 00		TBD	
• Developmental Test				
Milestone II - EMD	TBD		TBD	
• Development Test Start - Land Based				
• Development Test Start - Ship Based				
• Operational Test Start				
• System Integration Test				
Milestone III - Production	TBD		TBD	
• MSE Start				

listic Missiles (SRBMs), low cross section cruise missiles, Unmanned Aerial Vehicles (UAVs), and other air breathing threats to the force; (2) immediate deployment for early entry operations with as few as six C-141 sorties; (3) mobility to move rapidly and protect maneuver force assets during offensive operations; (4) a distributed architecture and modular components to increase survivability and flexibility of employment in a number of operational configurations; and (5) a significant increase in firepower while greatly reducing manpower and logistics requirements.

In August 1990, the Corps Air Defense Capability MNS was validated by the JROC. The Corps SAM program was approved by the DAB to enter the concept definition phase. A Corps SAM Operational Requirements Document (ORD) was jointly developed and approved by the Army and Marine Corps. The DAB also directed the Corps SAM program to aggressively pursue international cooperation in the development of the Corps SAM system. On February 20, 1995, a Statement of Intent (SOI) was signed with the governments of Germany, France, and Italy to cooperatively develop and produce the MEADS to satisfy the Corps SAM operational requirements as well as the operational requirements of the other nations. The SOI provides the framework for the MEADS Program.

The MEADS Program began as a result of a 1990-92 "Program Cooperative Opportunity Survey." The U.S. Under Secretary of Defense (Acquisition and Technology) (USD(A&T)) invited the German Government to cooperate with the United States in the development of a medium-range air and missile defense system. The French Government also invited the German Government to join the SAMP-T program. In April 1994, a Corps SAM draft Request For Proposal (RFP) was released. The French and German Governments expressed a desire to participate in the Corps SAM program in June 1994. At this time, MEADS was accepted as the acquisition strategy to meet the U.S. Corps SAM requirement.

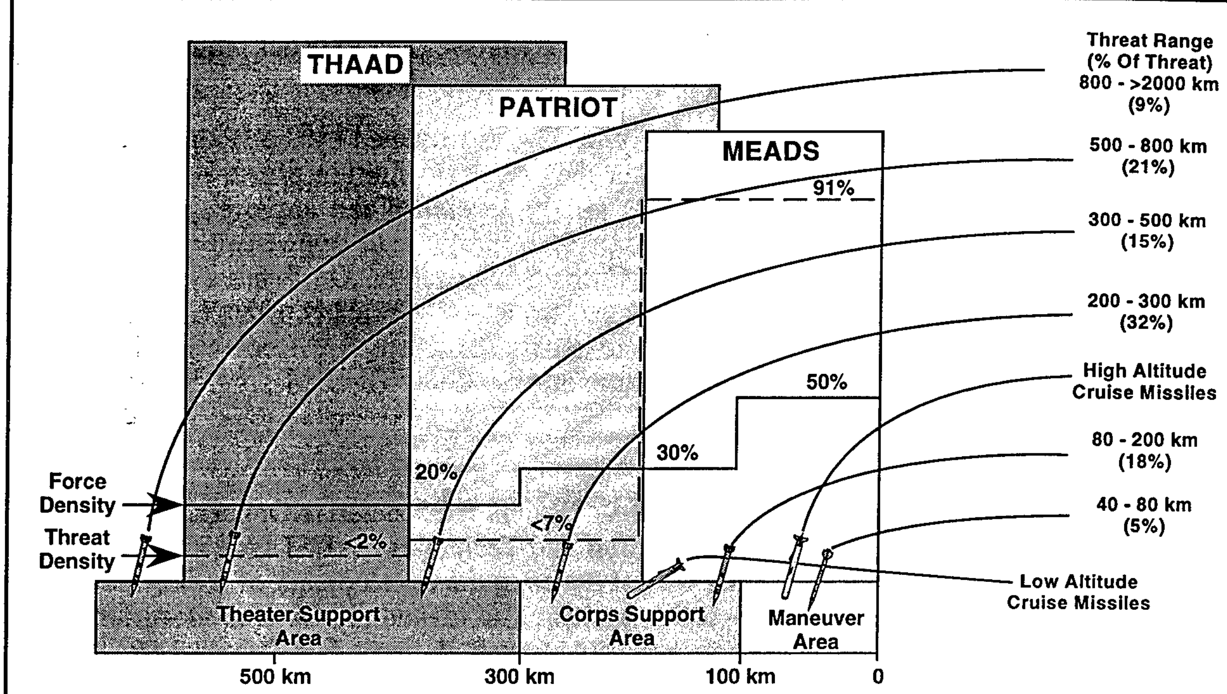
The MEADS SOI approval initiated MEADS Memorandum of Understanding (MOU) negotiations. A series of nine MOU negotiation meetings were held between February 1995 and February 1996. France withdrew from the MEADS program prior to final approval of the MOU. The MOU was modified to a trilateral MOU and signed by the United States, Italy, and Germany and entered into effect May 28, 1996. The MOU serves as the basis for program execution.

The MEADS will be a lower-tier component of the TMD active defense pillar that will provide low-to-medium altitude air defense, anti-tactical ballistic missile defense, and cruise missile defense. MEADS will be lightweight and modular in order to be highly transportable and mobile. MEADS will provide protection of maneuver forces and point defense of critical assets from early entry through decisive operations against multiple, simultaneous, 360° attacks by various classes of tactical missiles, UAVs, and air breathing threats, which may employ conventional and/or WMD warheads. MEADS will be compatible and interoperable with other Army, Joint Service, and allied systems expected to participate in joint/combined operations in the 21st Century. The MEADS operational requirements were harmonized between the participant countries and documented in the MEADS Initial International Operational Requirements Document dated February 29, 1996.

MEADS will play an important role in a layered missile defense strategy. Approximately 90% of the anticipated missile threats fall into the MEADS area of responsibility. These threats drive the MEADS system design towards a highly mobile and capable air defense system able to provide

and receive cueing data from other theater sensors and utilize national sensor data. Figure 2-15 shows MEADS' role in layered missile defense.

Figure 2-15. MEADS Role In Layered Missile Defense



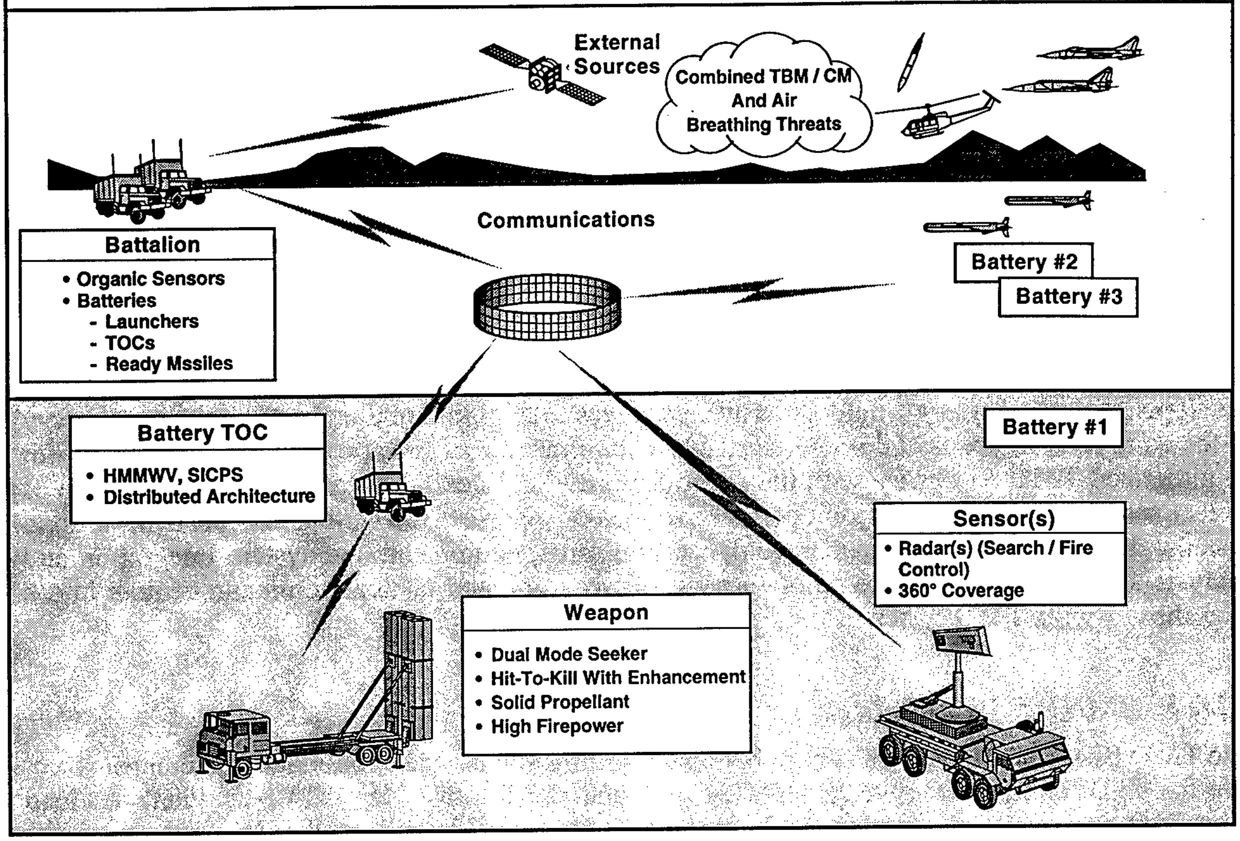
MEADS can be deployed as a single battle element/battery, or as a battalion operating from geographically displaced locations. Each battery contains a battery Tactical Operations Center (TOC), 360° sensor(s) for surveillance and fire control, and launchers with high firepower. The weapon is projected to be a hit-to-kill, dual pulsed solid propellant missile with lethality enhancement and a dual mode (IR/RF) seeker. All system components will be employed in a distributed architecture using high capacity tactical communications. Since each battle element/battery can operate autonomously, one battle element/battery can be moving with the maneuver forces while other batteries are defending vital assets.

External cueing from national and theater sensors is vital to the success of MEADS, especially against the low flying cruise missile threat. Over-the-horizon data from these sensors will allow MEADS to engage low flying cruise missiles at tactically significant ranges. Figure 2-16 is a conceptual drawing of the MEADS operational environment/battlespace.

FY 1996 efforts resulted in the following accomplishments:

- Completed negotiations and approved PD-V MOU;
- Established NATO MEADS Management Agency (NAMEADSMA) in Huntsville, AL;
- Awarded International Teaming Contracts.

Figure 2-16. MEADS Description



Work planned for FY 1997:

- Initiate PD/V phase;
- Begin negotiations for design and development phase MOU;
- Conduct system requirements review.

Work planned for FY 1998:

- Conduct SDR;
- Continue PD/V phase;
- Release design and development phase RFP.

2.9.3 *Airborne Laser (ABL) Program*

The ABL program entered the PD/RR phase in November 1996, which will demonstrate all necessary technologies required for acquiring, tracking, and killing theater ballistic missiles in the boost phase. This will be accomplished by building and testing the prototype ABL aircraft. The PD/RR phase will be completed in FY 2002 with lethality demonstrations against boosting TBMs. Following successful demonstrations, the program will proceed into a relatively short

EMD phase in FY 2003. Production will provide an Initial Operational Capability (IOC) with three aircraft in FY 2006 and a Full Operational Capability (FOC) of seven aircraft in FY 2008.

2.10 Battle Management/Command, Control, Communications, Computers, and Intelligence (BM/C^{4}I)

Interoperability in Battle Management/Command, Control, Communications, Computers, and Intelligence (BM/C^{4}I) is essential for joint TMD operations. Accordingly, BMDO continues to take an aggressive lead to establish an architecture that all the Services can build upon and is actively pursuing three thrusts, described below, to ensure an effective and joint BM/C^{4}I for TMD. The BMDO TMD BM/C^{4}I program integrates the C^3 components of multiple, independently developed programs into a single, cohesive, seamless system that realizes the maximum synergy of the combined weapons and sensor systems. The primary goal is to provide the warfighter with an integrated TMD capability with the interoperability and flexibility to satisfy a wide range of threats and scenarios. From its joint perspective, BMDO oversees the various independent weapon systems developments and provides guidance, standards, equipment, and system integration and analysis to integrate the multitude of sensors, interceptors, and tactical command centers into a joint theater-wide TMD system.

2.10.1 BM/C^{4}I Architecture

The TMD BM/C^{4}I architecture is built upon the existing and planned command and control structure for TAD. During FY 1996, the TMD Command and Control Plan (TMD C^2 Plan) received Joint Staff approval and included an operational architecture based upon the three primary functions of joint operations: planning, coordination, and execution. Deliberative planning occurs primarily at the higher levels of command and is generally non-real-time. Force coordination takes place at the tactical commander level (CRC, TAOM, TF TOC, CIC) and involves near real-time decisions. Execution is accomplished by the direct linkage of the sensor to the shooter to put metal on target and involves real-time actions. Figure 2-17 describes this spectrum of planning, coordination, and execution. The rapid timeframes associated with the execution of TMD require closely coordinated command and control for centralized planning and guidance with decentralized execution. To ensure optimized planning and guidance, BMDO is focused on accomplishing the horizontal linkages among the theater-level command and control centers that could be deployed in various combinations over time from one theater or contingency to another.

The TMD BM/C^{4}I architecture to support the operational architecture for planning, coordination, and execution is built around three overlapping networks: a Joint Planning Network (JPN), a Joint Data Network (JDN), and a Joint Composite Tracking Network (JCTN). The JPN is a non-real-time/near real-time network building upon the Global Command and Control System (GCCS) to support the centralized planning and guidance. The JDN is a near real-time network based primarily on the TADIL-J (JTIDS) datalink to provide overall situational awareness and weapon coordination. The JCTN is a real-time network to directly link sensors and shooters from all the Services to provide fire quality information to take full advantage of the synergy of multiple systems. The execution function will be supported by JCTN, which is a mix of the JDN and the Navy's Cooperative Engagement Capability (CEC). Figure 2-18 shows how these networks overlay on the operational functions. Note that the networks overlap. The highest priority for near term implementation is the JDN. Figure 2-19 shows an example of the participants in the JDN. All Services

Figure 2-17. Spectrum Of Planning, Coordination, And Execution

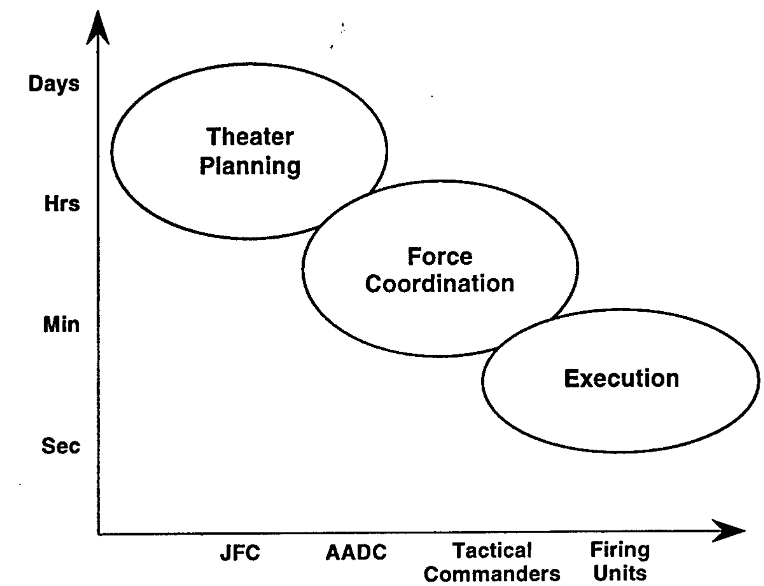
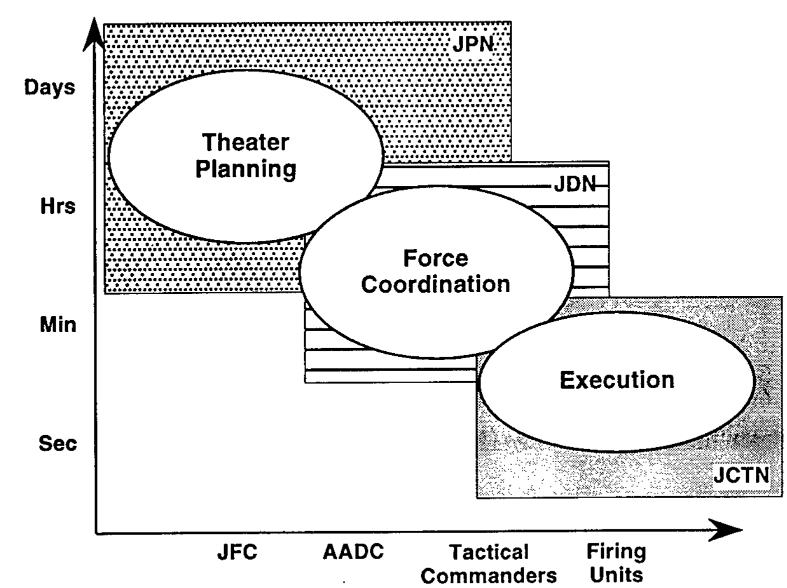
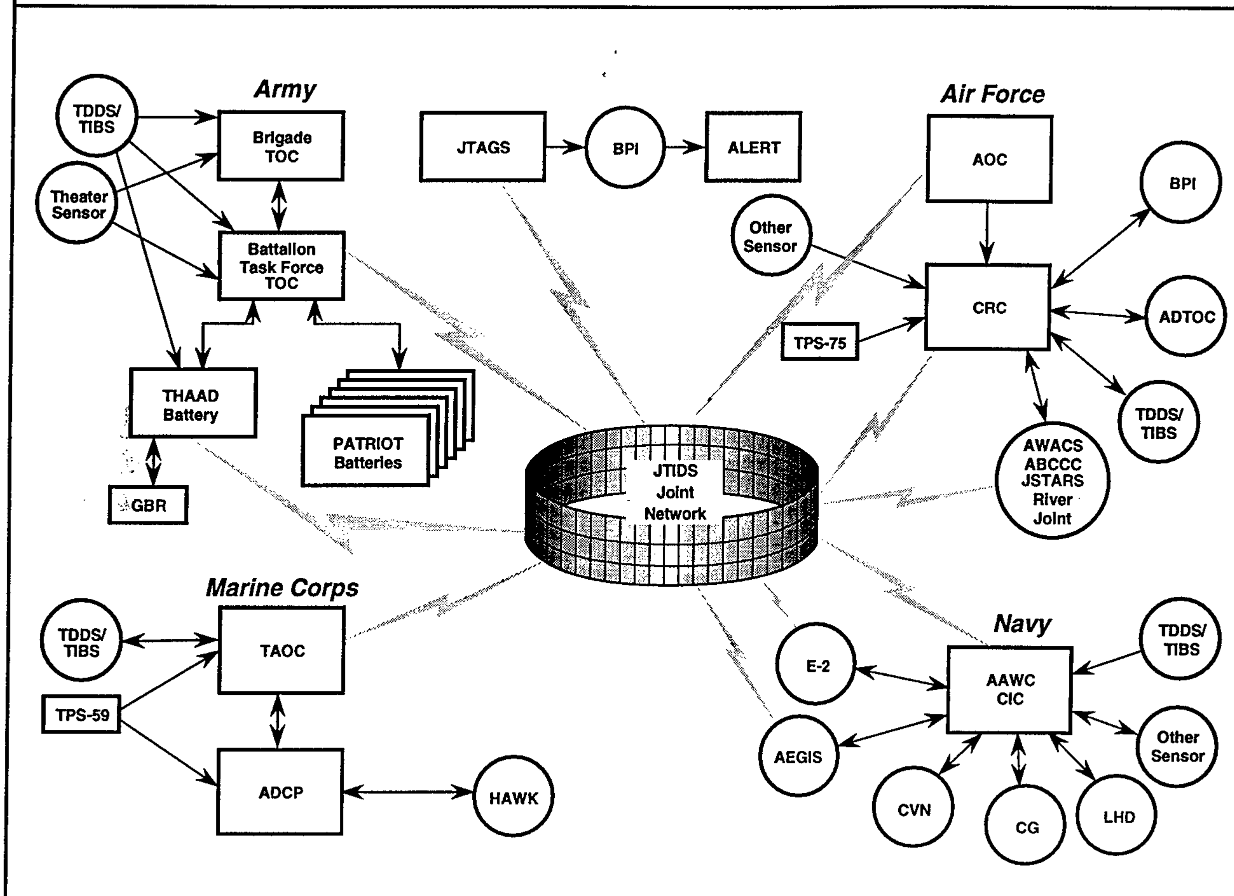


Figure 2-18. BM/C⁴I Networks



will interoperate via this net, which will allow early cueing of sensors and greater opportunity for TBM engagements. This joint data distribution will contribute to the success of engagements and mitigate leakage of hostile missiles through defenses.

Figure 2-19. BM/C4I Communications Network



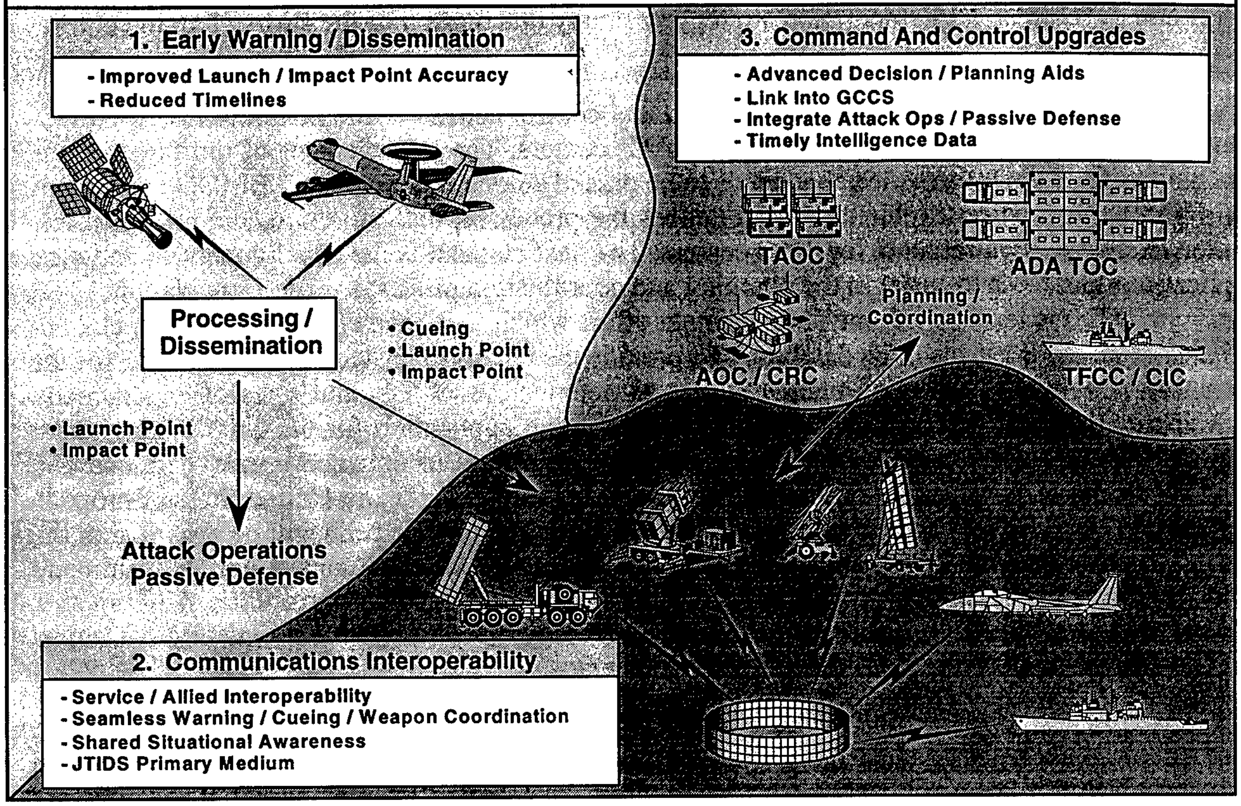
The intelligence portion of the architecture focuses on TIBS and TDDS. TIBS and TDDS are satellite broadcast systems which disseminate information from theater and national intelligence resources. TMD forces rely on TIBS and TDDS, in combination with the JDN, for receipt of launch warning information produced by tactical processors of DSP data (e.g., JTAGS in the theater or ALERT/TACDAR in CONUS).

2.10.2 *BM/C^{4}I Thrusts*

BMDO has three major thrusts to the TMD BM/C^{4}I program as illustrated by Figure 2-20.

The first thrust is to improve the timeliness and accuracy of early warning and track data from space and airborne IR platforms. The early cueing data can extend the target acquisition range of fire control radar systems, and in many cases increase the weapon system's shot opportunities and defended area. DSP was originally designed to detect strategic ballistic missile launches. To improve DSP performance for theater ballistic missiles, BMDO sponsored the Army/Navy-led Tactical Surveillance Demonstration Enhancement Program. The program prototyped a DSP stereo processing capability which formed the basis for the currently deployed JTAGS and ALERT ground processing stations. The Services now have responsibility for these fielded systems; however, BMDO continues to fund new cueing and warning-related technologies to further enhance the active defense, passive defense, and attack operations capabilities of TMD systems. JTAGS/

Figure 2-20. Three TMD BM/C4I Thrusts



ALERT have been integrated into the TIBS/TDDS networks to ensure timely dissemination of warning and cueing data directly to the shooter. JTAGS/ALERT and the TIBS/TDDS have improved Desert Storm warning data accuracy and timeliness by orders of magnitude. DSP will eventually be replaced by SBIRS and TIBS/TDDS will be replaced by the Integrated Broadcast System (IBS). BMDO is also working with the Services and USSPACECOM to minimize the impact to TMD systems during the transition.

The second thrust focuses on the need for a seamless, interoperable joint data net to rapidly exchange weapon coordination and cueing data and to provide the shooter and the tactical command centers with a consistent air and missile picture. This exchange of track data among units over a large area provides the ability to comprehend the battle situation beyond organic sensor range of individual participants, enhances organic radar acquisition by providing the means for cueing, and provides theater commanders with a consistent tactical picture for decision making. BMDO, with the Services and the Defense Information Systems Agency/Joint Interoperability Engineering Organization (DISA/JIEO), selected the Link-16 (TADIL-J) as the primary TMD datalink and successfully led a joint Service panel to define new data standards to support TMD. The standards have been joint Service and DoD agency-approved and have also been submitted for NATO acceptance. Several of these message standards have been approved by NATO for testing and BMDO has successfully tested the messages on the USMC ADCP. The program offices received the new standards described in the second thrust and are in the process of implementing the necessary software to integrate communication hardware with the various host platforms. BMDO continues to monitor and influence program offices acquisition activities to ensure JTIDS/Link-16 procurement and integration funding and timelines support TMD timelines.

BMDO sponsored an extensive study initiated in FY 1996 to determine the full value added by a system such as the Navy's CEC to TMD. The results of the study will help to better define the JCTN and develop an implementation strategy to satisfy this portion of the BM/C^4I architecture.

The third thrust focuses attention on command and control centers at the planning and coordination level of TMD above the weapon systems' C^2 centers. The first element of the thrust is the determination of the information that needs to be passed among these centers. BMDO is developing a TMD Information Architecture that defines the processes, data structure, and critical information exchange requirements for these centers. The next element is the development of software applications and tools to assist in the planning and coordination processes. The Joint National Test Facility (JNTF) is leading a Joint TMD Planner effort which will have common weapons characteristics of all the Services in its database and provide the means to provide TMD guidance for the executing activities in terms of such activities as defended asset lists and rules of engagement. This application will be consistent with and offered as an application for the GCCS. This thrust puts contingency deployable prototype C^2 centers in the field to enhance user experience and input regarding requirements refinement. A prototype TMD Cell for the United States European Command (USEUCOM) has been provided to the CINC, and similar cells will be provided to the United States Pacific Command (USPACOM) and the United States Central Command (USCENTCOM) to identify unique requirements in their areas of responsibility. Additionally, BMDO will join the Army efforts to field brigade-level Air Defense Tactical Operations Centers (ADTOC) and support the TMD aspects of this program.

BMDO is employing a Systems Integration and Interoperability contractor to help document and define the BM/C^4I Architecture. An Interoperability Description Document (IDD) will provide detailed descriptions of the interfaces and functionalities needed between each command and control node. A System Road Map will provide guidance on how and when each of the systems will achieve required interoperability.

In a continuous effort to validate the C^4I architecture and to measure the progress of the three BM/C^4I thrusts, BMDO is responsible for testing integrated BM/C^4I for TMD. This includes BMDO-sponsored exercises which will use the facilities of the JNTF and the Advanced Research Center (ARC) to refine the information architecture through user interactions, and quantifying performance parameters to be met by Service programs. Additionally, BMDO will use end-to-end simulations, man-in-the-loop tests, and Hardware-In-The-Loop (HWIL) tests to validate BM/C^4I requirements and determine that those requirements have been met. To meet the specific needs of TMD testing, System Integration Tests (SITs) have been defined which piggyback on live missile firings. Prior to and following a SIT, a series of HWIL tests will be conducted using the TMD System Exerciser (TMDSE) to simulate the operational environment and to drive each element participating via HWIL. As a distributed HWIL, the TMDSE stimulates the TMD data processors via a simulated environment to demonstrate TMD system responsiveness and performance as an integrated whole in scenarios unachievable with live-flight testing.

2.10.3 Theater Missile Defense BM/C^4I Integration Group (TBIG)

BMDO has established a broad-based IPT with participation by the Services, CINCs, and DoD agencies to work BMDO's integration and interoperability objectives. That group, the TMD BM/C^4I Integration Group (TBIG) meets regularly to share information and to secure the coordination and collaboration of all affected programs in defining and implementing the appropriate C^4I solu-

tions for an integrated TMD capability. This information sharing helps identify divergences so that problems can be solved. The TBIG involves both operators and material developers in sharing information that supports Service activities pertaining to programmatic planning, standards, the TMD C^4I functional baseline, and interface control documentation. Participation by the unified CINCs, in addition to the Service user/operator representatives, provides a current user's perspective.

OSD and the Joint Staff are active TBIG participants. The OSD representatives ensure that initiatives pursued by the Services/agencies are in consonance with OSD policies for C^4I and information systems. The TBIG meetings also provide an opportunity for OSD to inform the Services/agencies of directives that apply to the TMD community. This exchange of information keeps all parties informed. The Office of the Joint Chiefs of Staff also sends representation to each TBIG meeting to share information on officially approved joint doctrine, CONOPS, and other efforts to improve worldwide C^2 systems (such as the GCCS) with which the TMD family of systems will eventually interface. The DISA/JIEO provides the technical expertise to implement and define the OSD and Joint Staff policies.

The TBIG has established subordinate working groups to investigate several issues. The TMD Subgroup of the Joint Multi-TADIL Standards Working Group is perhaps the most successful TBIG effort. The JTIDS Network Management Working Group is tackling the issues of managing the complex JTIDS network. The T4P Working Group is a forum to coordinate the sensor-to-shooter issues associated with TES, TACDAR, TIBS, and TDDS. A Risk Management group has been formed to focus on specific risk issues and means to eliminate or mitigate the effects of risks. The Information Architecture, previously mentioned, is being developed with the help of a working group established by the TBIG. All these groups provide the information sharing and issue resolution opportunities essential to produce an interoperable BM/C^4I system.

FY 1996 efforts resulted in the following accomplishments:

First Thrust: Launch Warning Dissemination.

- Developed multisensor tracking algorithm;
- Implemented situation targeting algorithms;
- Integrated C^2 connectivity to national assets.

Second Thrust: Communications Interoperability.

- Conducted modeling and analysis of JTIDS network structure in support of TMD;
- Developed interoperability certification test plan;
- Demonstrated lower-tier/Joint interoperability;
- Updated Information Exchange Requirements (IER);
- Began implementing JTIDS TMD message sets on selected BM/C^4I platforms. Started integration on Air Force platforms (Ground Tactical Air Control System, Cobra Ball, and Rivet Joint);

- Initiated study on relaying TMD data to theater areas beyond the line-of-sight limitations of a JTIDS network;
- Began work on AEGIS cruiser/JMCIS interface;
- Completed JTIDS TMD message set validation in North East Asia and South West Asia theaters;
- Defined joint JTIDS Range Extension (JRE) operational and demonstration architecture;
- Continued correlation analysis and testing as required in the Modeling, Analysis, and Simulation Center;
- Developed Data Link Handbook;
- Completed debris techniques analysis plan;
- Supported MIDS development.

Third Thrust: Command and Control Upgrades.

- Prototyped the decision support aids for JFACC battle management;
- Developed, simulated, and demonstrated prototypes of the recommended TBMCS application for the distributed command and control nodes;
- Completed testing of JTIDS Navy Command and Control Processor (C2P) modifications;
- Conducted TMD war game;
- Conducted tests to refine command and control procedures;
- Continued prototype integration into ADTOC weapon systems of BM/C^4I capabilities;
- Began implementation of TBMD modifications necessary for the Advanced Combat Direction System (ACDS);
- Refined Time Critical Target Aid (TCTA) prototype, began software integration into the Theater Battle Management Core System (TBMCS) databases;
- Conducted Distributed Battle Management (DBM) platform impact assessments on AWACS, JSTARS, and/or the Control Reporting Center;
- Began TMD intelligence planning tool development: completed one country study and started a second country study;
- Evaluated software maturity for operational tests;
- Integrated JTIDS into USMC ADCP;
- Initiated cue acceptance development for AN/TPS-59 and TAOM TMD upgrades.

Work planned for FY 1997:

First Thrust: Launch Warning Dissemination.

- Continue to integrate C^2 connectivity to national assets.

Second Thrust: Communications Interoperability.

- Participate in joint TBMD interoperability demonstrations;
- Demonstrate Army enclave interoperability;
- Integrate JTIDS into Army systems and additional Air Force platforms (complete AWACS TMD message set integration, start AWACS fleet upgrade, continue GTACS TMD message set integration, and begin Air Operations Center and Airborne Command and Control Capsule);
- Continue evolution of JMCIS/TBMD segment;
- Complete correlation analysis testing;
- Develop joint JTIDS Range Extension implementation plan.

Third Thrust: Command and Control Upgrades.

- Perform AOC/CRC upgrades for TMD;
- Begin software integration of TMD messages;
- Participate in TBMD workshops;
- Conduct C^2 tests to refine C^2 procedures;
- Continue implementation of TBMD modifications for ACDS;
- Complete TCTA software integration into TBMCS databases;
- Model and simulate the DBM system concept, begin DBM technology risk mitigation;
- Normalize intelligence preparation of the battlespace country studies;
- Continue TMD intelligence tool development, begin software integration into Combat Intelligence Systems databases;
- Integrate JTIDS into Army systems;
- Field Joint TMD Planner software V1.0.

Work planned for FY 1998:

First Thrust: Launch Warning Dissemination.

- Implement improved correlation software for TIBS/TDDS.

Second Thrust: Communications Interoperability.

- Definition of a point-to-point Link-16 STANAG;
- Complete the AEGIS/JMCIS interface control documents;
- Implement TADIL-J onboard the E-2C aircraft;
- Implement TADIL-J onboard additional Air Force platforms;
- Develop TADIL-J range extension software and hardware;
- Continue JTIDS procurement for JDN;
- Initiate actions for a JCTN;
- Distribute joint correlation analysis results and guidance;
- Continue AWACS JTIDS TMD message set fleet upgrade;
- Continue Ground Tactical Air Control System, Air Operations Center, and Airborne Command and Control Capsule TMD message set integration;
- Develop joint JRE capability in accordance with implementation plan.

Third Thrust: Command and Control Upgrades.

- Upgrade JMCIS TMD software segments;
- Field two Tactical Operations Centers to Active Army brigades;
- Field JTMDP V2.0;
- Develop an automated intelligence database function;
- Deliver TMD Battlefield Situation Display;
- Conduct initial testing of TAOM TMD modifications;
- Continue distributed battle management technology risk mitigation;
- Develop automated intelligence database function.

2.11 Other Programs and Concepts

Other programs and concepts include BPI and SBIRS. The following sections describe these activities. Figure 2-21 shows the active defense framework with some of these systems included.

2.11.1 Boost Phase Intercept (BPI)

BPI systems are designed to defeat TBMs in the powered portion of flight. This is a time critical phase of flight in which the BPI systems will detect, target, and destroy TBMs in a matter of seconds. Only in this boost phase can U.S. forces actively defend against TBMs and provide a significant deterrence not to launch WMD. With BPI, the enemy must face the potential of having chemical, biological, or nuclear weapons fall back upon its own territory. The ABL is being

Figure 2-21. TMD Active Defense Framework Core Programs And Other Concepts

	Land	Sea	Air
Upper	THAAD System (FUE FY 04; UOES FY 99)	Navy Theater Wide TBMD Initial Intercept FY 00 UOES / FUE TBD	Boost Phase Intercept - Airborne Laser (Air Force) - UAV BPI (BMDO)
Lower	PAC-3 Configuration Three (FUE FY 99) Corps SAM / MEADS	AEGIS With SM-2 Block IVA (FUE FY 02; UOES Software FY 98)	
	JTAGS ALERT TACDAR	DSP	TPS-59

BM/C^{4}I

Core Program* — Other Programs And Concepts

* Emphasizes Programs Underway Or Upgrades To Existing / Fielded Systems

Combination Gives CINC Flexible Deployment / Employment Options

developed by the Air Force to accomplish BPI. The UAV BPI is being pursued as a backup to the ABL.

2.11.2 Kinetic Energy Boost Phase Intercept (KE BPI)

The primary objective of the KE BPI program has been realigned in an effort to develop and demonstrate lightweight endoatmospheric vehicle technologies to supporting advanced TMD interceptors.

2.11.3 Space Based Infrared System (SBIRS)

The SBIRS Program is an Air Force acquisition effort to develop and field a consolidated space-based nonimaging infrared surveillance system. The SBIRS Program is an essential element of the NMD architecture and while space-based tracking is not necessary to the operation of ground-, sea-, or air-based TMD systems, the deployment of SBIRS would enhance the capabilities of those systems. A deployed space-based midcourse tracking system will provide a significant extension of the range and effectiveness of TMD systems, and allow them to operate effectively under adverse conditions. Also, a space-based midcourse tracking capability may be

needed to augment ground-based radars and extend the range of intercepts against the evolving longer range theater missile threats. Providing TMD systems with over-the-horizon sensor cueing will greatly enhance each system's performance. SBIRS data can be used to cue the radars (ground- or ship-based) to acquire warheads or it can be used to target the interceptors before the TBMs come within radar range. The additional battlespace gained with space-based midcourse tracking allows more shot opportunities, increases the probability of negating the threat, and allows the threat to be destroyed further from defended assets. This will decrease the probability of damage to friendly forces as a result of the intercept and otherwise allow warfighters to maintain the initiative.

For a more detailed discussion of SBIRS, see section 3.5.5.

2.12 Joint Force Activities

Joint force efforts include the Commanders-in-Chief (CINCs') TMD Assessment Program and Combined Warfare Activities. These efforts are discussed below.

2.12.1 CINCs' TMD Assessment Program

The CINCs' TMD Assessment Program consists of operational exercises, war games, Planning Exercises (PLANEXs), and Warfare Analysis Laboratory Exercises (WALEXs). This program enhances the two-way communication between BMDO as the developer and the warfighting CINCs who are the end users of TMD systems. In support of the user, the CINCs' TMD Assessment Program provides a vehicle for the CINCs to assess their capabilities and shortfalls so that they may refine and articulate their TMD requirements and improve their current and future TMD operational capabilities. The program facilitates the development and refinement of TMD doctrine and CONOPS as part of the CINCs' and Joint Staff's overall theater operations plans.

In support of the developer, the CINCs' TMD Assessment Program provides lessons-learned which are fed back into system requirements and the acquisition programs. In FY 1994, the program name was changed from the CINCs' TMD Experiments Program to the CINCs' TMD Assessment Program to emphasize feeding back lessons-learned into weapons system acquisition requirements, and Service and joint doctrine development. From BMDO's perspective, the program is a valuable vehicle for collecting the earliest data at a low cost on both current and future TMD system performance in a near tactical operational environment. Although the Joint Force Directorate is the BMDO point of contact for this program, all directorates within the BMDO Deputy for Theater Air and Missile Defense interact with and benefit from this program.

The objectives of the CINCs' TMD Assessment Program are:

- Improve current TMD capabilities;
- Document user TMD requirements;
- Facilitate development of TMD doctrine/CONOPS;
- Serve as the "bridge" between user and developer;
- Document existing TMD capabilities;
- Gain CINC support for BMDO programs.

To conduct the program, representatives from the CINCs' staffs participate in workshops where developers and the doctrine community brief the latest developments in their respective areas. The CINCs then develop prioritized goals based upon their past TMD experience and promising new technological and doctrinal developments. Working with BMDO's Joint Force Directorate, these goals are then translated into an assessment plan for the succeeding two years. The assessments are overlaid on established CINC/BMDO-sponsored WALEXs, war games, and live/simulated exercises to ensure that TMD capabilities are evaluated in the context of the full spectrum of joint and combined force operations. A BMDO-sponsored TMD PLANEX is made available to each CINC to provide, over a two-day period, basic instruction on the TMD pillars and operations, and to facilitate the design and conduct of TMD exercises and war plan preparation.

The results of the assessments provide operational data directly to the developer, and assist the CINCs in updating their integrated priority lists and operational requirements documents. Lessons-learned from these assessments support the development and refinement of TMD CONOPS; operational requirements; and joint, combined, and Service doctrine. The CINCs also gain valuable operational experience in conducting TMD operations, which immediately enhances the planning and execution of their warfighting capabilities and the development of TMD requirements for future weapon system deployments. The Joint Force Directorate ensures that lessons-learned are also presented to the acquisition community.

An increasing number of theater commands are participating in the program. From the program's inception in 1988 until 1993, USEUCOM was the only operational command to participate. In 1993, USCENTCOM and U.S. Forces Korea (USFK) joined. In 1994 U.S. Pacific Command (USPACOM) and U.S. Forces Japan (USFJ) began to participate as well. In 1995 U.S. Atlantic Command (USACOM) joined the program. BMDO provided liaison officers to help USACOM initiate TMD activities.

Major TMD CINC assessments include Optic Needle, Optic Cobra, Ornate Impact, and numerous war games. Optic Needle is the TMD portion of USEUCOM exercises and includes Central Enterprise, Optic Windmill, Matador (NATO exercise), Atlantic Resolve, Cold Fire (NATO Central Region Exercise), U.S.-U.K. Wargame, and Dynamic Mix (JTF/JFACC exercises). Optic Cobra is the TMD portion of Joint USCENTCOM exercises and includes Roving Sands. Optic Cobra assesses the ability of USCENTCOM to exercise all four pillars of TMD in both a live and simulated environment. Ornate Impact is the TMD portion of a USFK command post exercise which evaluates all four pillars of TMD in a simulated environment. The Joint Task Force Exercise series sponsored by USACOM is the template for increasingly complex TMD assessments. The USPACOM exercises focus on bilateral TMD issues throughout the Pacific basin and preparing U.S. Third Fleet Carrier Battle Groups for deployment to USPACOM and USCENTCOM.

In 1995, BMDO and USACOM concluded a memorandum of understanding establishing three BMDO liaison officer positions (Army, Navy, and Air Force) at USACOM. These billets provide USACOM with a TMD cell and the ability to participate more fully in the development and evaluation of joint, combined doctrine and requirements. Some of the specific liaison officer duties include planning coordination for USACOM/BMDO-sponsored CINC TMD assessments, planning and coordinating TMD war games, and working USACOM TMD issues and requirements.

2.12.2 Combined Warfare Activities

The Combined Warfare programs are joint programs with our allies and friends. These programs have three major objectives. The first objective is to reduce the costs of fielding TMD systems by sharing the cost burden of development, production, and operation. The second objective is to help our allies and friends understand the impact of the ballistic missile threat on their countries and to access innovative foreign technologies, systems, and unique capabilities. The third objective is to facilitate military ties to define common requirements to help ensure the interoperability of TMD weapon systems used by the United States, its allies, and friends. The FY 1994 Defense Authorization Act directed the Secretary of Defense to develop a plan to coordinate development and implementation of TMD programs with our allies which satisfies these objectives. BMDO prepared the plan, entitled "Report to Congress on Plan to Coordinate Development and Implementation of TMD Programs with Allies." The report was submitted to Congress in the fourth quarter of FY 1994.

In addition, the international cooperative programs support U.S. policies. The programs may strengthen U.S./allied mutual security commitments and counterproliferation policies and strategies. Fully developed programs should result in protection for U.S./allied forces and underpin the National Command Authorities freedom of action in crisis situations.

BMDO's approach is to build on the earlier foundation of bilateral research and development programs. These programs have led other countries to recognize existing and emerging threats of ballistic missile attacks. The strategy for international cooperation complements the TMD acquisition strategy for emphasizing near-term improvements, fielding the core programs, and developing advanced concepts.

2.13 TMD Test Program

TMD testing consists of individual MDAP testing and TMD "Family of Systems" (FoS) integration and interoperability tests. MDAP TMD test and evaluation efforts will be accomplished by the individual Service acquisition programs and will encompass all requirements mandated in DoD guidance. These test programs will be fully documented in each acquisition program Test and Evaluation Master Plan (TEMP). Testing to assure interoperability among systems acquired by an individual Service will generally be executed by that Service but will also be assessed in FoS testing. All tests, including tests of individual acquisition programs and TMD FoS, will be conducted in accordance with existing U.S. treaty obligations.

BMDO will sponsor testing to assure inter- and intra-Service operability and interoperability of the TMD Family of Systems with external systems. TMD FoS test requirements are derived from the *BMD Capstone Operational Requirements Document* (ORD), from individual system ORDs, and other documentation such as the TMD Command and Control Plan. TMD FoS requirements in the Capstone ORD include the responsiveness and effectiveness of the consolidated TMD FoS against specific tactical ballistic missile threats; characteristics of the common air picture which must be maintained among TMD C^2 centers; and specific information exchange requirements. Requirements not addressed in Service-specific test programs are included in the *TMD Capstone Test and Evaluation Master Plan (TEMP)*, which is a road map for future test planning and coordination among test programs, resources, and other organizations. Interoperability certification of

each major acquisition program will be provided by the Joint Interoperability Test Command as required by DoD Directive 4630.5 and Chairman, Joint Chiefs of Staff Instruction 6212.01A.

Chapter 3

National Missile Defense

Chapter 3
National Missile Defense (NMD)

3.1 Introduction

The Department of Defense (DoD) is working to develop a National Missile Defense (NMD) capability to defend the United States from an emerging Rest-of-World (ROW) rogue state ballistic missile threat or against a limited accidental or unauthorized missile launch. Toward this end, DoD established the NMD Deployment Readiness Program, which positions the United States to respond to a threat as it emerges.

In early 1996, DoD completed a comprehensive review of its Ballistic Missile Defense Program, followed by a decision to shift the NMD Program from a technology to a deployment readiness program. Current program strategy is based on the "3+3" concept -- a three year development and planning phase, that, if necessary, could be followed by a three year system development and deployment phase. DoD is fully committed to the first phase of the "3+3" NMD program. In response to the shift from technology to deployment readiness, the Undersecretary of Defense for Acquisition and Technology (USD(A&T)) designated NMD as an Acquisition Category-ID (ACAT-ID) Major Defense Acquisition Program (MDAP).

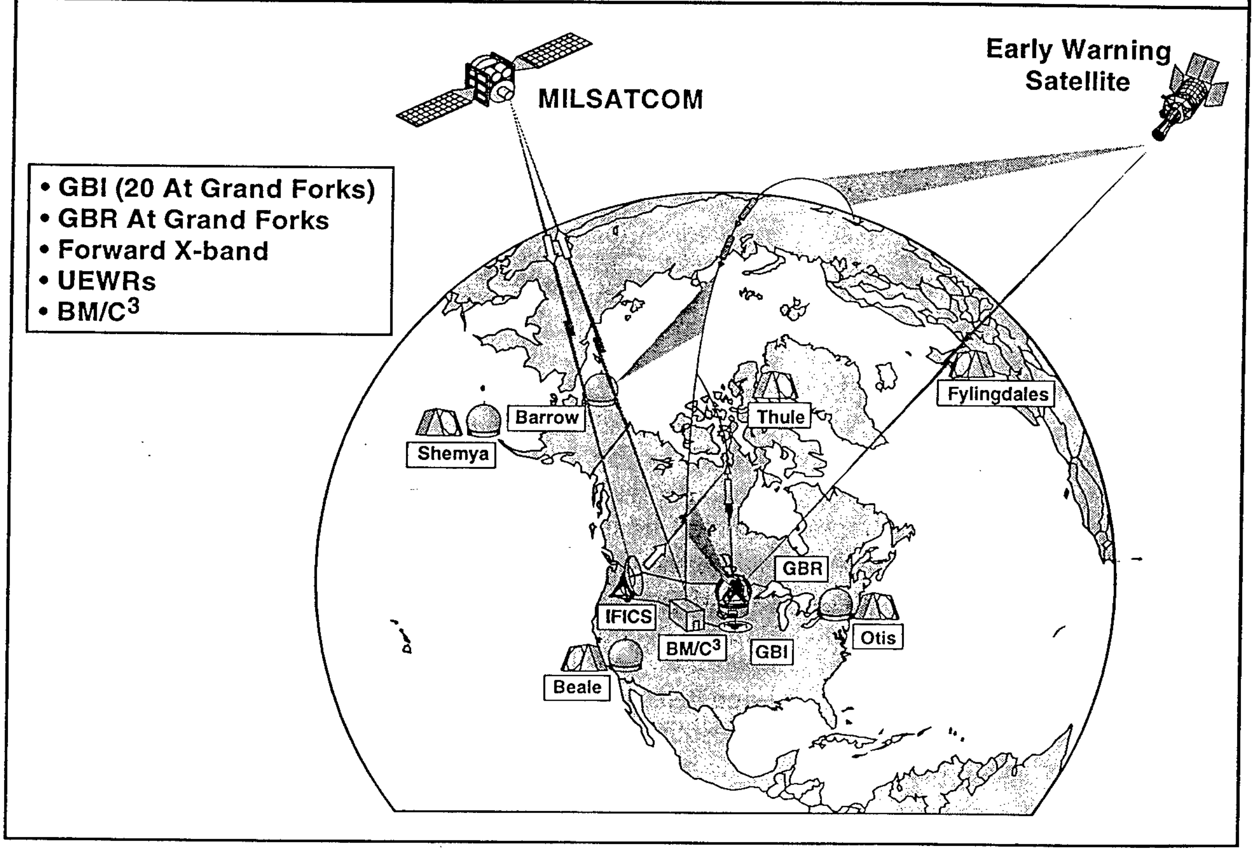
NMD funding changed based on Congressional direction and DoD's NMD program strategy, which will permit the completion of a development program leading to the demonstration of the NMD system in an Integrated System Test (IST) in FY 1999. Funding shifted forward in the Future Year Defense Program (FYDP) with allocations of approximately an additional $100 million per year in FY 1997-1998. Congressional funding increases provided $375 million in FY 1996 and $325 million in FY 1997 for NMD above DoD's request.

During the initial development phase of the NMD "3+3" Program, subsystem elements will be integrated into a limited capability system, culminating with an Integrated System Test (IST) in FY 1999. A decision to deploy could be made as soon as 2000 based on a successful demonstration of system capability and validation of a ballistic missile threat. If the threat and program progress warrant a decision to deploy, then an Initial Operational Capability, designated as Capability 1, could be deployed as early as 2003. However, if a deployment decision is deferred, the program will continue improving the NMD deployment readiness posture by advancing the technology of each element while maintaining the capability to deploy the system within three years of a decision--ultimately leading to the development of an objective system capable of defending against more sophisticated threats, designated as Capability 2. The Department's goal is to achieve an NMD deployment readiness posture that ensures deployment is at most three years away from a decision to deploy. Given the uncertain timing of the threat, the specific scenario in which a threat may emerge, and the length of time required to deploy a system to defend against these threats, the NMD Deployment Readiness "3+3" strategy accommodates the uncertainty of the threat to the United States while allowing an orderly evolution of capability as the technology matures.

3.1.1 System Concept

If deployment of an NMD system is mandated soon after the FY 1999 IST, an initial architecture could be in place by 2003. That architecture would consist of the following basic elements integrated as a system: (1) a Ground Based Interceptor (GBI) element capable of receiving and processing in-flight target updates, performing onboard target selection, and providing reliable target destruction; (2) a Ground Based Radar (GBR) to act as the primary fire control sensor; (3) an Upgraded Early Warning Radar (UEWR) and other Forward-Based X-band Radars (FBXRs) as required; (4) early warning satellites to detect a ballistic missile launch (i.e., the Defense Support Program (DSP) satellite or Space Based Infrared System (SBIRS)-High); and (5) a Battle Management/Command, Control, and Communications (BM/C^3) element for system integration, informed decision making by humans in control, and engagement planning and execution. The Capability 1 architecture, depicted in Figure 3-1, will meet the threshold values of the user's operational requirements as established in the Joint Requirements Oversight Council (JROC)-validated National Ballistic Missile Defense (BMD) Capstone Requirements Document (CRD) and Joint Operational Requirements Document (ORD), and will provide high levels of operational effectiveness against a limited threat comprising a few simple reentry vehicles from a ROW country.

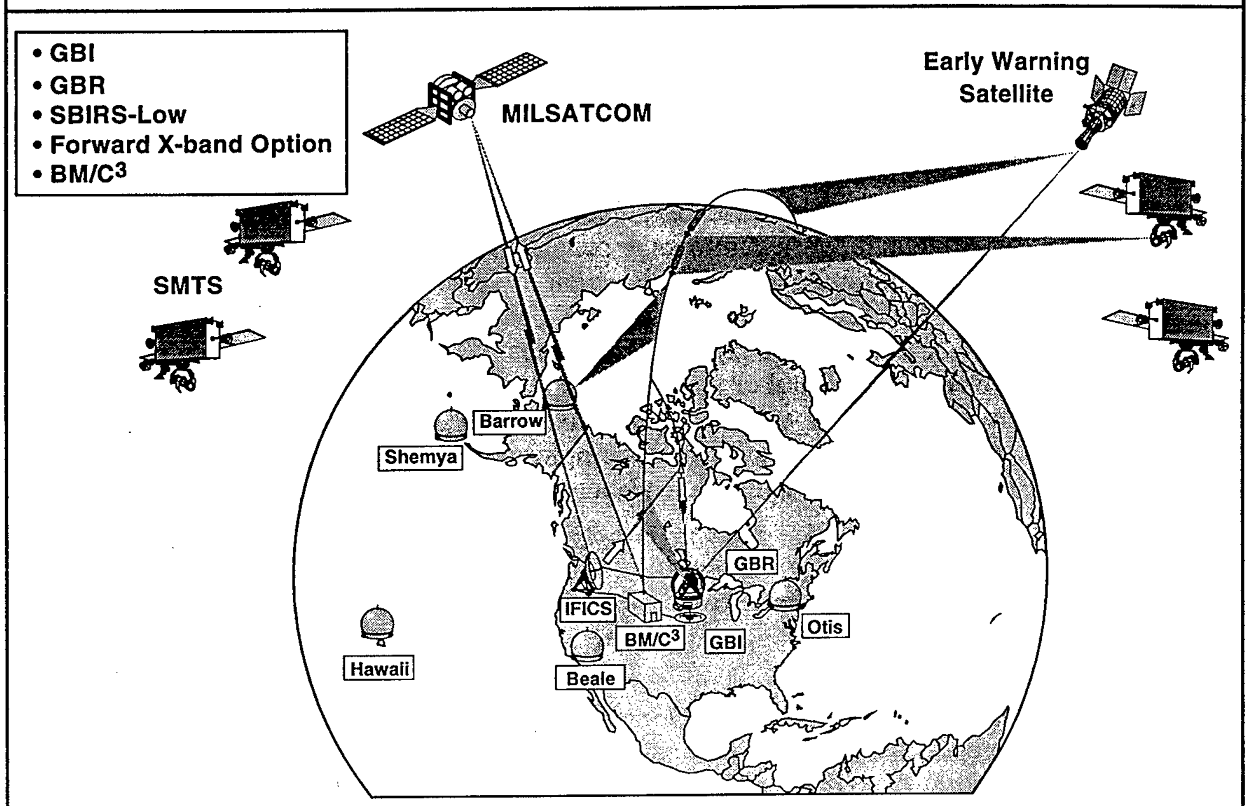
Figure 3-1. Capability 1 NMD Architecture



If the deployment of an NMD system is deferred, the NMD "3+3" Program will continue to improve the deployable defense system as element technologies advance and new elements are introduced until the objective system architecture, Capability 2, is attained. Such an architecture

would add a constellation of SBIRS-Low space-based sensors to the above-mentioned subsystem elements and would specify sensor and interceptor ground sites that are designated to deal with a specific threat. A representative architecture that could be deployed and would meet the objective system requirement of providing a high level of protection against a modest number of more complex threats is depicted in Figure 3-2.

Figure 3-2. Capability 2 NMD Architecture



3.2 Threat

3.2.1 National Intelligence Estimate

A National Intelligence Estimate on the emerging missile threats to North America during the next 15 years was issued, representing the views of the Director of Central Intelligence with the advice and assistance of the U.S. Intelligence Community. The Defense Intelligence Agency (DIA)-validated Strategic Threat Assessment (STA) contains the DIA-validated threats which the NMD system is designed to counter.

The intelligence community has concluded that no country, other than the major declared nuclear powers, will develop or otherwise acquire a ballistic missile in the next 15 years that could threaten the contiguous 48 states; only a North Korean missile in development, the Taepo Dong 2, could conceivably have sufficient range to strike portions of Alaska or the far-western Hawaiian Islands, but the likelihood of it being operational within five years is very low.

The threat from an accidental or unauthorized launch from the former Soviet Union or China is assessed to be remote. The number of former Soviet Union strategic ballistic missiles, the number of bases and submarines from which they could be launched and the number of countries where they are based are being reduced by the Strategic Arms Reduction Treaty (START) and the Cooperative Threat Reduction (CTR) program. In addition, a ballistic missile detargeted according to the 1994 Clinton-Yeltsin agreement, in the highly unlikely event it were launched accidentally, would land in the ocean.

3.2.2 Design to Threat

The design-to-threat is categorized with the labels System Threat-1 (ST-1) through ST-4, representing the increasing sophistication and quantity of future threats. ST-1 includes up to four rudimentary first generation warheads. ST-2 includes up to four warheads with little sophistication beyond a rudimentary ascent shroud in order to present a "cold" target in the midcourse phase of the warhead trajectory, and includes no jammers or penaids. ST-1 and ST-2 are typical of the type that could be expected through indigenous development efforts in ROW countries such as North Korea, Iraq, or India. ST-3 includes up to four warheads of more sophisticated design, and could include simple jammers or penaids, or a higher yield nuclear warhead. This would be typical of a portion of the threat from an accidental or unauthorized launch from Russia or China or an authorized launch from an ROW country after it has obtained more sophisticated technology through proliferation. ST-4 includes up to 20 warheads of complex design, including advanced responsive jammers, and penetration aids, or a Multiple Independently-targetable Reentry Vehicle (MIRV) weapon.

3.3 Requirements

The National BMD CRD and the Concept of Operations (CONOPS) for Ballistic Missile Defense of North America represent the approved baseline requirements documentation for the NMD Program. Together, they form the basis for developing the NMD Joint ORD, validated by the JROC in March 1997. DoD Order 5000.2-R and MOP 77 allow the NMD Joint ORD to become the primary driver of the NMD system requirements.

3.3.1 National Ballistic Missile Defense (BMD) Capstone Requirements Document and NMD Joint Operational Requirements Document (ORD)

The National BMD CRD contains the United States Space Command's (USSPACECOM) top-level operational requirements that will be used as the framework to develop the NMD system. The NMD CRD, validated August 24, 1996, supersedes the December 1994 Capstone ORD for BMD to address only National BMD needs. The NMD Joint ORD, approved in March 1997, has the same key performance parameters as the CRD. The key performance parameters identified in the Joint ORD establish the minimum capabilities needed to perform its mission of defending the United States from limited ballistic missile attacks. The Joint ORD defines threshold and objective standards for the operational effectiveness an NMD system capability based on assured human-in-control and automated BM/C^3 decision support systems. The Joint ORD forms the basis for developing the BMDO NMD System Requirements Document (SRD), which establishes the development program baseline for the NMD system architecture, system performance and interface requirements, and element performance requirements. From this baseline system, additional capabilities could be added to defend against the objective threat as future changes dictate.

3.3.2 Concept of Operations (CONOPS) for Ballistic Missile Defense of North America

The CONOPS for BMD of North America, validated by the Commander-in-Chief, U.S. Space Command (USCINCSPACE), establishes the operational guidance on the manner in which USSPACECOM plans to operate and employ the National Missile Defense capability. The CONOPS establishes the user's intentions for centralized control of NMD with decentralized execution through Service components. The CONOPS also specifies the procedures to ensure the development of an operationally suitable and effective NMD system, which enables detailed development of the BM/C^3 architecture.

3.4 Program Overview

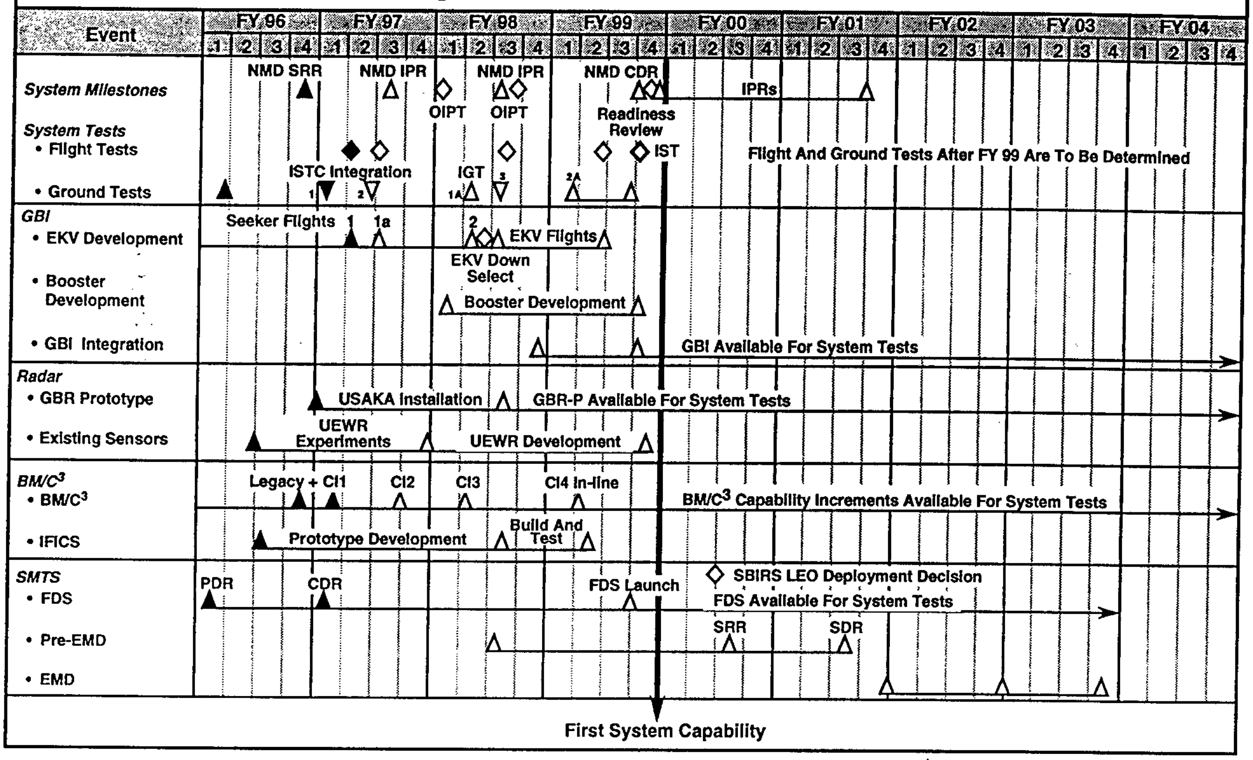
Since passage of the Missile Defense Act (MDA) of 1991, the part of the Ballistic Missile Defense Program designed to protect the United States against a limited strike has evolved from a program to acquire a system to a program to be ready to acquire a system for deployment. In July 1992 the Secretary of Defense sent Congress a plan to implement the MDA that called for deployment of production hardware in FY 2002 and options for fielding a User Operational Evaluation System (UOES) as early as FY 1997. Following the change of administrations in 1993 and an extensive Bottom-Up Review (BUR) of DoD programs, strategic defense objectives changed from acquiring the Limited Defense System part of the Global Protection Against Limited Strikes (GPALS) program to the NMD Technology Readiness Program. The Technology Readiness Program was intended to address uncertainty in the timing of when a threat to the United States might emerge. It was structured to increase the capability of the key elements of a strategic defense system so that, over time, deployment opportunities of increasing performance capabilities would be available. A second key objective of the Technology Readiness Program was to reduce the time to deploy an NMD system by planning efforts such as award of contracts in a manner that would save time after a decision to deploy were made.

In 1994 Congress responded to the Administration's Technology Readiness Program by endorsing a "hedging" strategy for national missile defense and emphasizing the importance of reducing lead-times for deployment of a very limited, prototypical defense capability against a "rogue" missile threat. Congress stated in the National Defense Authorization Act for FY 1995 that the "...objective (for the NMD program) should be to develop and test, as rapidly as available NMD funding will permit, a limited, UOES-type capability." Furthermore, the Secretary of Defense was asked to study how the Technology Readiness Program could be changed to meet a threat against the United States that could emerge at the end of 2000, 2005, or 2010. In 1995, the Director, BMDO presented to the Congress three excursions that addressed possible changes to the baseline Technology Readiness Program. One excursion showed how the baseline program could be enhanced to reduce risk and support an initial deployment by 2003. A second excursion showed how an NMD emergency response system could be deployed as early as 2000. A third excursion showed how advanced technology such as active sensors and directed energy could be accelerated to form a basis for more robust systems than in the NMD baseline program. All three excursions required additional funding to the FY 1996 President's Budget and Department of Defense Program Objectives Memorandum (POM) for the out-years.

With the completion of DoD's 1996 Program Update Review of the BMD Program and the resultant shift of focus from a technology readiness to a deployment readiness program, the Department

decided to proceed with, and fully commit to, the first three years of the "3+3" program. In April 1996, the USD(A&T) designated NMD an MDAP ACAT-ID, which is currently in the Program Definition/Risk Reduction (PD/RR) phase. The NMD "3+3" program schedule is shown in Figure 3-3.

Figure 3-3. NMD "3+3" Schedule



To accomplish this strategy, the Department spent the additional $375 million appropriation added to the FY 1996 President's Budget. In addition, the FY 1997-98 POM levels have been increased by $100 million for each year. Furthermore, the Department will spend the additional $325 million appropriated over the FY 1997 President's Budget.

Currently, BMDO is focusing on developing the documentation for the late-August 1997 NMD Program Review. Program Review objectives are twofold: (1) to review program and documentation status and (2) to establish the NMD milestone schedule.

3.5 National Missile Defense Elements

BMDO is entering a procurement to obtain a Lead System Integrator (LSI) contractor for NMD. The LSI will integrate all NMD element development to include the GBI, GBR, BM/C^3, UEWR, FBXR, and SBIRS-Low when it becomes available. During an initial concept development phase, competing contractors will develop and deliver detailed plans and schedules for the follow-on execution phase, with a goal of providing the most cost-effective design to meet user requirements. Specifically, for example, contractors are required to conduct life cycle trade studies on

GBI booster options, including Minutemen and other new, modified, or off-the-shelf boosters. Plans and designs for other architecture elements may evolve during the concept development and execution phases. Accordingly, the system element descriptions which follow reflect the design concepts of individual development efforts as they currently stand. These elements may differ from those used in the ultimate LSI design selected for development.

3.5.1 Ground Based Interceptor (GBI)

The GBI element of NMD consists of a nonnuclear Exoatmospheric Kill Vehicle (EKV) mated to a high-speed booster in addition to launch and support equipment. The GBI will be capable of destroying intercontinental ballistic missile threats in the midcourse phase of flight based on handover from advanced sensors. It uses precommit and in-flight target update data provided by BMD sensors through the BM/C^3 element to determine booster fly-out trajectory, acquire the threat cluster, and designate the target for KV homing. In the endgame, the EKV seeker is used to identify the target from among other associated objects and home in on it. After selecting an aim point and performing final maneuvers, the EKV hits its target, destroying it by force of impact. Figure 3-4 identifies GBI components and provides a description of its technical characteristics.

Initially, the GBI program will focus on developing and testing the EKV to demonstrate the required capability for the NMD mission. Two contractors are developing EKVs based on distinctly different technical approaches. As a result of increased funding in FY 1996, the two competing efforts will continue through FY 1997. These experiments will reduce intercept flight test risk by providing the data necessary for the EKV to demonstrate onboard discrimination and target selection prior to intercept flights. Four EKV flight tests will take place in FY 1997-99 before the FY 1999 NMD system demonstration.

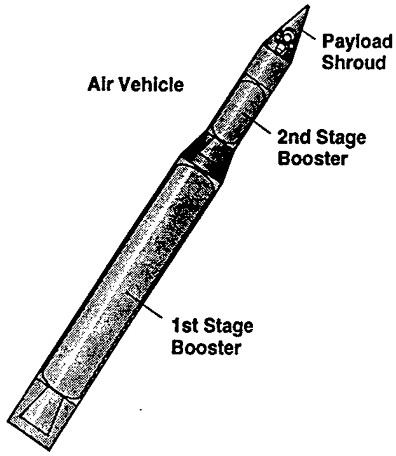
Beginning in FY 1998, the GBI program will develop a new booster or modify an existing booster which can satisfy NMD coverage and timeline requirements. The required launch and support equipment will also be developed. When the booster has been tested to ensure proper operation and payload deployment, it will replace the Payload Launch Vehicle (PLV) which is currently used in testing and is planned for use as a surrogate booster for the GBI in the FY 1999 IST. To achieve the objective NMD system capability, the GBI will incorporate increased hardening and any applicable component technology upgrades which have been developed in parallel with the initial EKV design.

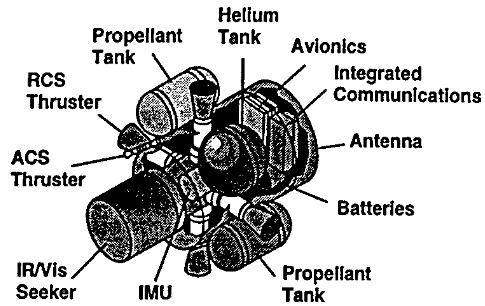
3.5.2 Ground Based Radar (GBR)

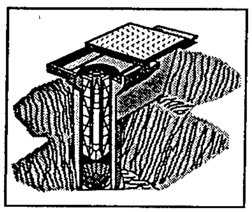
A GBR prototype is being developed as part of the three year NMD development phase to support flight testing and system integration. The NMD Ground Based Radar-Prototype (NMD GBR-P) (Figure 3-5) will leverage off existing TMD GBR technology. The NMD GBR is an incremental program that leverages developments of the Theater High Altitude Area Defense (THAAD) radar program to resolve the critical issue associated with development and deployment of an NMD GBR. Beginning in FY 1997, the THAAD Demonstration/Validation (Dem/Val) radar will be reconfigured into GBR-P, providing a cost and risk reduction. The NMD GBR-P effort will develop a test bed radar to resolve critical technology issues associated with development of an NMD-GBR and provide the primary fire control sensor to support integrated NMD system testing at the United States Army Kwajalein Atoll (USAKA).

Figure 3-4. GBI

System Components







Launch Site

Kill Vehicle Characteristics

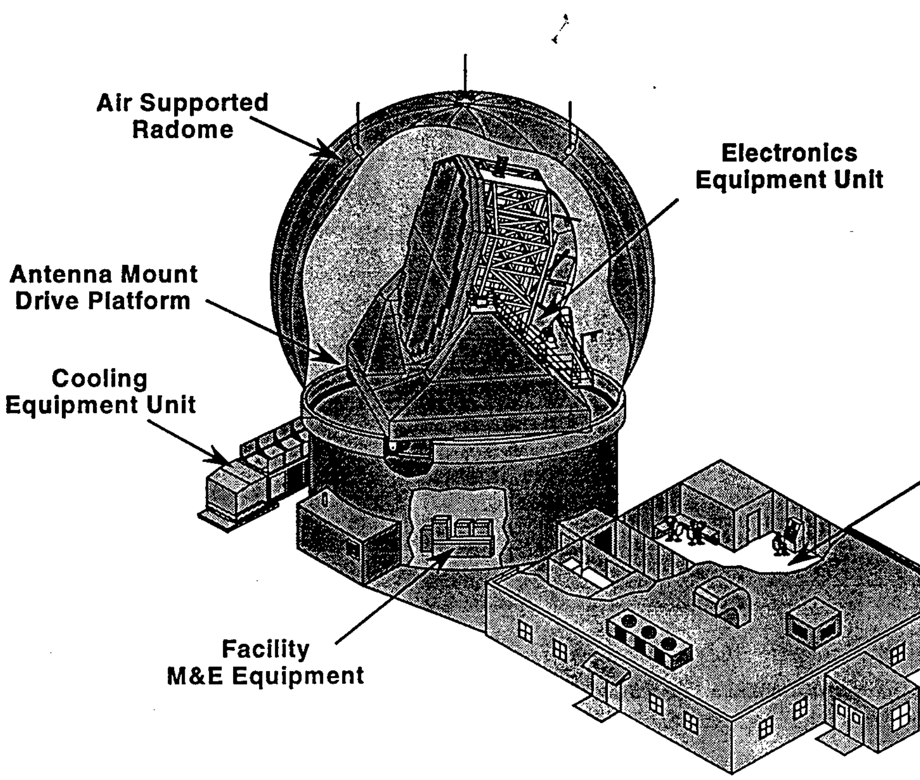
- Kill Vehicle (35-45 kg)
  - Multispectral Passive LWIR Seeker
    - HgCdTe Or Si:As FPA
  - Guidance And Navigation
    - IFOG Inertial Measurement Unit
    - Solid-state Accelerometers
  - Divert Propulsion
    - Liquid Bipropellant
    - High Acceleration
  - Cold Gas Attitude Control System
- Booster
  - 2 Or 3 Stages
  - > 7 km/sec Burnout Velocity

Description

- GBI Is The Weapon Element Of NMD
- Interceptor Development / Testing Is Integrated With NMD System Development / Testing
  - FY 1997-98 Sensor Flights (IFT-1 And IFT-2)
  - FY 1998-99 Kill Vehicle Flights (IFT-3 And IFT-4)
  - FY 1999 NMD System Demonstration
- Focus Is On Deployment Readiness
  - "3+3" Development Strategy

As a primary fire control sensor for the NMD system, the radar performs surveillance, acquisition, track, discrimination, fire control support, and kill assessment. To support precommit, the radar will plan and schedule its sensor resources to search autonomously or in response to a cueing handover, acquire, track, classify/identify and estimate object trajectory parameters. The radar will pass to the engagement planner all objects which it classifies as threat targets or other potential targets. The engagement planner will use these data to develop a weapon tasking plan for the interceptor and for the planning of sensor tasking required for postcommit. In postcommit, the radar schedules its sensor resources to continue tracking the target to provide an In-Flight Target Update (IFTU) and a radar target object map to the assigned interceptor while collecting data to aid in target kill assessment.

Figure 3-5. Ground Based Radar - Prototype (GBR-P)



- 16,896 T/R Modules
- 123 m^2 Aperture
- 2,000-4,000 km Range
- Mechanical Slew
  - ± 178 deg Az
  - 0-90 deg El
- Electronic FOV
  - 25 deg Az
  - 25 deg El

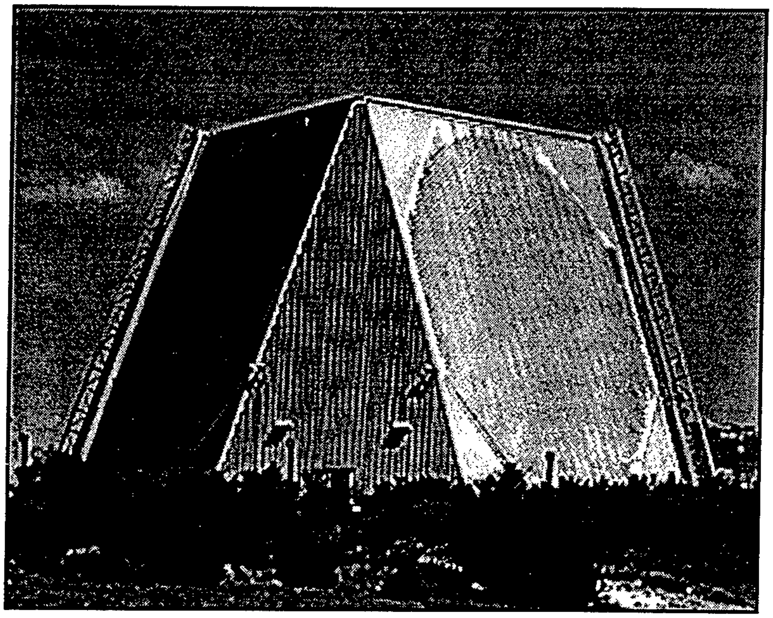
3.5.3 Upgraded Early Warning Radar (UEWR)

The NMD architecture incorporates existing Early Warning Radars (EWRs), which are part of the Integrated Tactical Warning/Attack Assessment (ITW/AA) System. When upgraded, the EWRs function as an early and midcourse tracking element prior to the deployment of the SBIRS-Low. The existing EWRs will require software and processing upgrades to track reentry vehicles effectively. BMDO is continuing its program to develop an Upgraded Early Warning Radar (UEWR). Figure 3-6 displays a typical UEWR.

The CONOPS for the UEWRs calls for cueing from the DSP to initiate a special search fence in the target's vicinity. After acquiring the missile, the EWR will concentrate energy on the missile and transmit tracking information to BM/C^3 assets over the time period that the radar tracks the missile.

A number of successful experiments, using modifications to the software of the PAVE PAWS and Ballistic Missile Early Warning System (BMEWS), show the UEWR's viability in performing early warning functions in support of the NMD mission. Based on these demonstrations, BMDO initiated a UEWR prototype program under an Air Force Executing Agent in FY 1997. Actual modifications to the UEWRs will not occur until a deployment decision is made. Other FBXRs could be developed and fielded to augment and fill the EWR radar coverage gap.

Figure 3-6. Upgraded Early Warning Radar



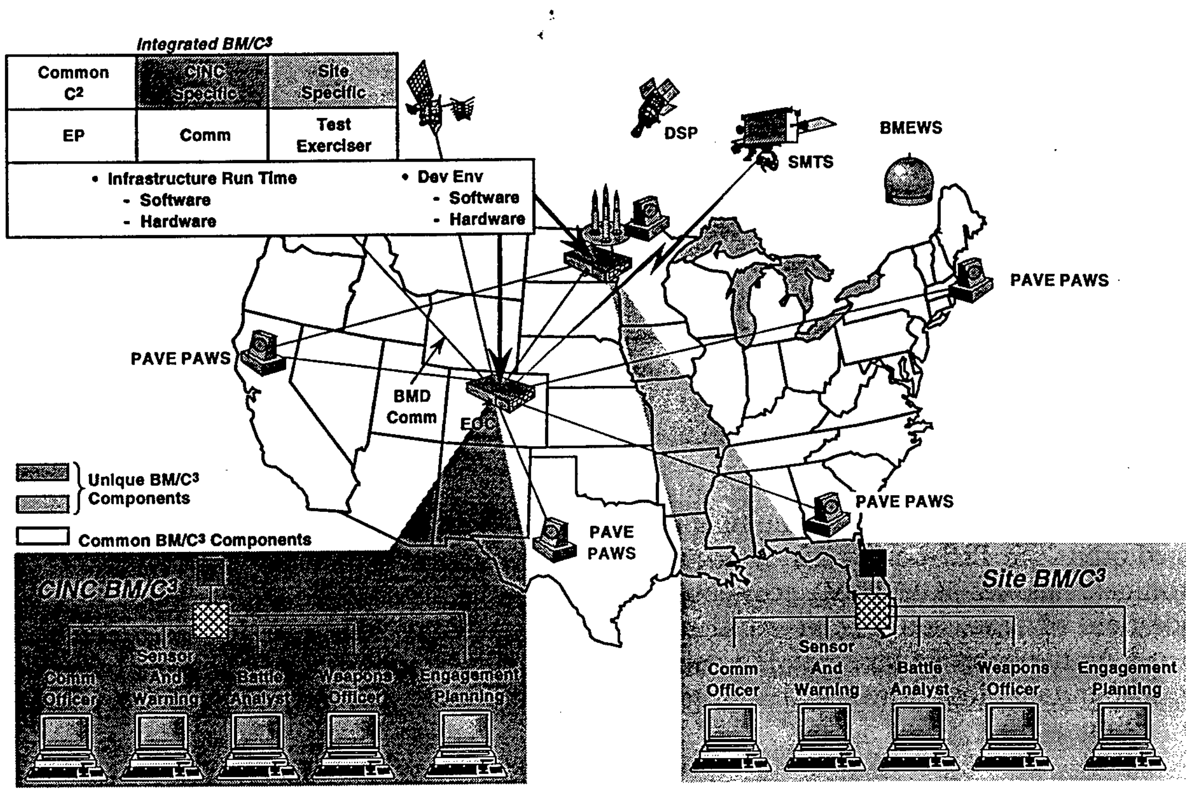
- **EWR (Other Existing Sensors)**
  - **Develop And Demonstrate Upgrades To EWR And Other Existing Sensors In Support Of NMD**
  - **Testing Of Prototype UEWR Software**
  - **Develop UEWR Simulation In Support Of Integrated Ground Tests (IGTs)**

3.5.4 *Battle Management/Command, Control, and Communication (BM/C^3)*

The NMD BM/C^3 element supports USSPACECOM and the North American Aerospace Defense Command (NORAD) Command and Control (C^2) of the NMD system with integrated C^2 decision support systems and automated engagement planning capabilities. The BM/C^3 element interfaces with existing C^2 systems and the NMD elements by a survivable communications subsystem comprised of line-of-sight radio frequency, Military Satellite Communications (MILSATCOM), landline/fiber-optic communications network, and the In-Flight Interceptor Communications System (IFICS). Figure 3-7 refers to the integrated BM/C^3 network for NMD. The BM/C^3 element functionally integrates the NMD system by supporting inter-element communications, processing sensor and intelligence data to create BM/C^3 knowledge bases that are used to support battle planning, C^2 decision making and sensor, interceptor and communications tasking balanced to best support command and human-in-control direction. The BM/C^3 element supports NMD BM/C^3 operations in peacetime and in all phases of conflict.

Additionally, an IFICS prototype is planned for development. The IFICS supports the transmission of BM/C^3 IFTU and Target Object Map (TOM) messages to the in-flight EKV that are required to refine targeting information and intercept the intended target. This effort will make use of available government communications systems to leverage an NMD IFICS prototype development.

Figure 3-7. Integrated BM/C3



The CONOPS for the BM/C^3 element calls for functionally redundant BM/C^3 personnel and equipment suites located near both the USSPACECOM/NORAD Cheyenne Mountain Center and the NMD intercept site. The BM/C^3 element design concept supports flexible operational configurations needed for USSPACECOM/NORAD NMD CONOPS dynamics as well as operational survivability in the event either site is degraded or unavailable.

The BM/C^3 project has successfully developed the initial BM/C^3 Capability Increment One (CI-1) and associated BM/C^3 Test Exerciser (TEx) capabilities, initiated User Assessment processes, and initiated design and development of BM/C^3 Capability Increment Two (CI-2). BM/C^3 CI-1 has been integrated into the Integrated Flight Test One (IFT-1) environment with BM/C^3 equipment suites at both the Kwajalein Missile Range (KMR) and the BM/C^3 Element Support Center at the Joint National Test Facility (JNTF) at Falcon AFB, Colorado, supported by a secure high data rate communications link. The test configuration will address the BM/C^3 element interfaces with the system test environments, the GBI test article, and will test BM/C^3 CI-1 functionality. BM/C^3 CI-1 will participate in IFT-1 and IFT-2 as well as Integrated System Test Capability (ISTC) Integration Test 1 and 2. BM/C^3 CI-2 will be integrated into this system's test environment to participate in IFT-3 and IFT-4 and Integrated Ground Test One-A (IGT-1A). CI-3 and CI-4 support test participation of increasingly complete BM/C^3 functionality required for an initial NMD deployment operational capability. Further the BM/C^3 project will continue the successful series of BM/C^3 demonstrations utilizing EWR systems to validate BM/C^3 capabilities to coordinate tasking of multiple sensor sources, cue sensors, and fuze track data for NMD purposes.

3.5.5 Space Based Infrared System (SBIRS)

The SBIRS Program, a necessary element in the objective NMD system, is an Air Force acquisition effort to field a consolidated space-based nonimaging infrared surveillance system that meets United States needs for missile warning, missile defense, technical intelligence, and battlespace characterization for the next two to three decades.

The SBIRS Program includes both high- and low-altitude components. The SBIRS-High component consists of four satellites in Geosynchronous Earth Orbit (GEO) and two infrared sensors on satellites in Highly Elliptical Orbit (HEO). The SBIRS-Low component, formerly known as Space and Missile Tracking System (SMTS), with satellites operating in Low Earth Orbit (LEO), complements SBIRS-High by providing a unique precision midcourse tracking capability to meet objective system performance in ballistic missile defense (both national and theater). A common ground-based processing capability will replace the DSP processing stations as well as Attack and Launch Early Reporting to Theater (ALERT) and will be the primary location for SBIRS mission processing, mission management, mission planning, and satellite and sensor control.

SBIRS-Low will be composed of multiple rings of small, lightweight spacecraft in low-altitude, inclined orbits. SBIRS-Low will have acquisition and track sensors onboard to detect, track, and discriminate missiles in the boost, post-boost, and midcourse phases. The acquisition sensor uses a wide field of view, and a short wavelength infrared scanning sensor to detect bright rocket plumes. As the boosters burn out, the narrow field of view staring tracking sensors take over, using medium and long wavelength infrared and visible detectors to provide precision tracking and discrimination.

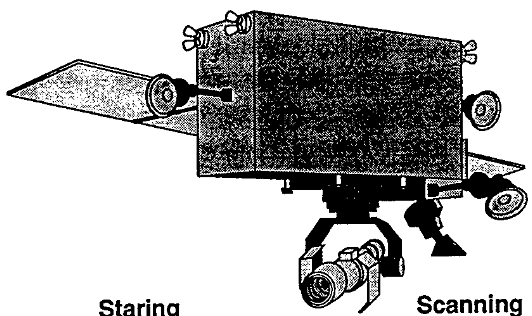
The SBIRS-Low component demonstration phase consists of two satellite efforts. The first is the Flight Demonstration System (FDS) to design, build, and fly two satellites which will demonstrate critical system capabilities in a real world environment. The second effort is the Low Altitude Demonstration System (LADS), which demonstrates critical sensor functions aboard a single satellite and maintains viable competition during the pre-EMD phase of acquisition leading to award of a single SBIRS-Low EMD contract.

The Office of the Secretary of Defense (OSD) recently directed that funding be provided for a SBIRS-Low initial launch in FY 2004, accelerating the program two years. The program is currently in the PD/RR phase of acquisition. Two contractor teams are currently competing with separate programs. TRW/Hughes is under contract to develop, fabricate, and fly two FDS satellites to be launched in FY 1999 to demonstrate operations and performance and to validate the design and costs of the SBIRS-Low concept. In September 1996, Rockwell was awarded a contract to provide risk reduction activities for SBIRS-Low. Rockwell will develop an alternative SBIRS-Low concept, LADS, which includes a flight experiment to be launched in FY 1999 and ground demonstrations to address additional operational aspects of SBIRS-Low.

Figure 3-8 provides a description of the SBIRS-Low component and a picture of the Flight Demonstration System (FDS) satellite.

Figure 3-8. SBIRS Satellite

Spacecraft



Description

- **Distributed Constellation In Multiple Rings**
- **Low Altitude, Inclined Orbits**
- **Small, Lightweight Spacecraft (≈600 kg)**
- **Wide Field Of View Acquisition Sensor**
  - **Horizon-To-Horizon Surveillance To Acquire And Track Boosters**
- **Narrow Field Of View Track Sensor**
  - **Above And Below-The-Horizon Tracking Of Boosters And Warheads**
- **Provides Passive Sensor Technology For Contingency Architectural Options**

Essential For Optimum Coverage

3.6 NMD Test Program

The NMD Test and Evaluation (T&E) program will be conducted in accordance with the NMD *Test and Evaluation Master Plan (TEMP)*. The NMD TEMP will establish the framework for a comprehensive NMD T&E program. The TEMP will capture a dynamic T&E process that accommodates an evolving architecture, supports the threat-driven acquisition strategy, baselines T&E resources, and is consistent with maturing program documentation.

In coordination with the developmental and operational test communities and the NMD program manager, the System Test director will ensure the effective determination of achieved system performance via testing. The NMD test program encompasses a continuum of simulations, IGTs, IFTs, and ISTs to assess the capability of the NMD system to perform the national BMD mission specified in the Joint ORD. An aggressive simulation program including complex Hardware-in-the-Loop (HWIL) and Software-in-the-Loop (SWIL) simulations will be used to make effective use of limited flight testing opportunities.

The NMD Deployment Readiness T&E program will demonstrate the incremental capability and interoperability of BM/C^3 systems, GBI, GBR, UEWR, forward-deployed X-Band radar, and space-based sensor elements of NMD. An evolutionary program of ground and flight tests will culminate with a fully integrated test of these systems in conjunction with IFT-5 in FY 1999. This test will demonstrate system performance effectiveness against a representative threat before a system deployment decision is needed. The T&E Program Integrated Product Team (IPT) established FY 1999 Test Program Objectives in the NMD TEMP. Numerous IGTs and a total of five

five IFTs will be conducted prior to the 2000 deployment decision review. Combined Development Testing and Operational Testing (DT/OT) will also be conducted during the initial development phase as a means to support an early deployment decision if necessary.

The NMD ISTC Hardware- and Software-in-the-Loop (HWIL/SWIL) System Test Integration Laboratory will be used to evaluate the system interfaces prior to this flight test. The NMD T&E program is based upon an incremental evaluation of the critical technical parameters of the system as prescribed to the test program in a set of operational requirements from the system engineering process. These critical technical parameters are Engagement Response Time, System Tracking Performance, System Discrimination Performance, System Engagement Performance, Multiple Engagement Performance, and System Kill Assessment Performance. Key features of the test program designed to evaluate these parameters and reduce acquisition risk include:

- Demonstrate integrated system capability and interoperability before the 2000 Deployment Decision;
- Accelerate development of the NMD Capability Test Tool for extensive and repeatable evaluation of element interfaces and system capability;
- Judicious use of flight tests to anchor models and simulations and NMD Integrated System Test Capability Tool;
- Leverage individual element test and simulation opportunities to collect data and evaluate system issues;
- Maintain focus on system-level functional tests while demonstrating time phased capabilities; and
- Reduce cost and delays through exploitation of Targets of Opportunity, demonstrations, and system simulations.

Given the prohibitive costs of conducting a statistically representative set of NMD flight tests, the development and use of the NMD ISTC allows achievement of statistical confidence in the readiness assessment of an NMD system to be deployed. The shift in focus to the NMD Deployment Readiness Program allows the individual element data processors and software to be available sooner, integrated into the NMD ISTC, and evaluated prior to the FY 1999 IST. This allows early identification of system interface design issues and risk associated with live flight testing. FY 1999 Test Program Objectives include demonstration of:

- End-to-end integrated system performance;
- End-to-end target detection, acquisition, tracking, correlation, and handover performance;
- Real-time discrimination performance;
- NMD system kill assessment capability;
- The ability of the NMD system to develop and coordinate battle engagement plans; prepare, launch, and fly out a designated weapon; and kill a threat representative target;

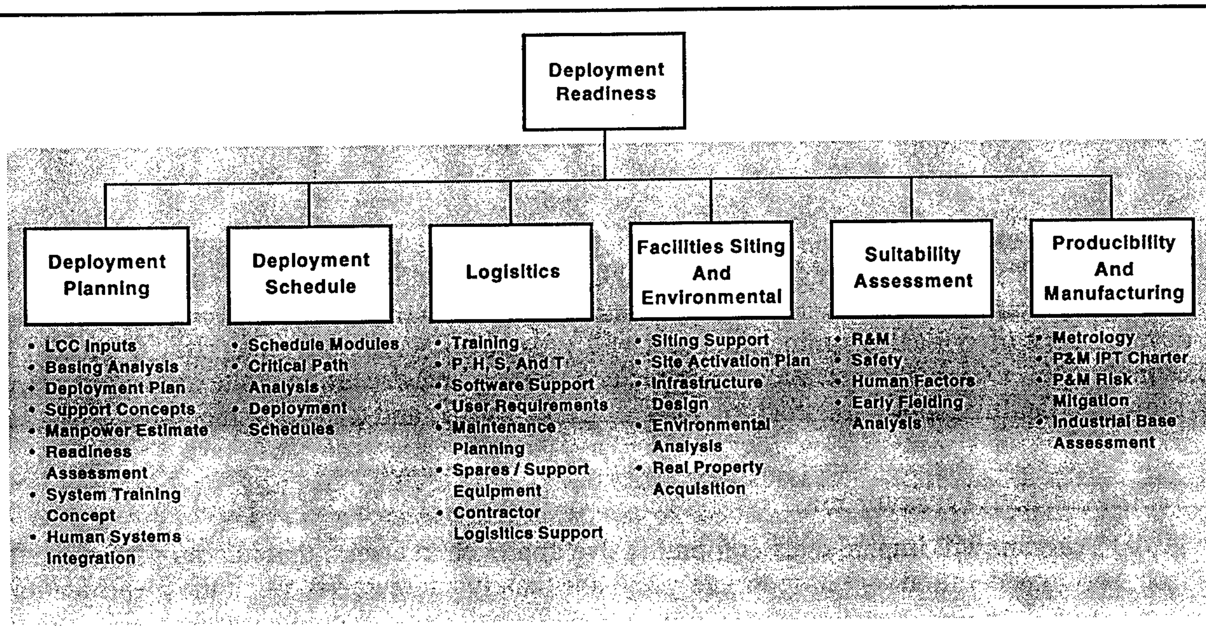
- Integration, interface compatibility, and performance of the NMD system, subsystem hardware and software, and human-in-control operations.

Modeling and Simulation (M&S) are used in the NMD Deployment Readiness Program to reduce the time, resources, and risks of this highly accelerated development process. Simulations and models are used extensively in the T&E program to represent complex environments and overcome the limitations of actual live testing. Areas of particular application include support to test planning, test design, test execution, and data analysis and reporting. Systems engineering and integration organizations employ M&S for system requirements trade-offs, balancing, and performance assessments against a wide range of threat scenarios.

3.7 Deployment Readiness

NMD Deployment Readiness Program efforts are being developed based on the requirement that an effective, suitable, and sustainable system can be deployed within three years following a deployment decision. The NMD deployment readiness process comprises a series of complimentary functional tasks including Deployment Planning, Deployment Schedule, Logistics, Facilities Siting and Environmental, Suitability Assessment, and Producibility and Manufacturing, as depicted in Figure 3-9 and described below.

Figure 3-9. NMD Deployment Readiness Activities



3.7.1 Deployment Planning

The shift in the NMD Program from technology readiness to deployment readiness has driven an

acceleration toward more intensive and integrated planning studies to achieve a more efficient deployment capability at lowest cost and risk. Integrated deployment planning is keyed to the progress of technical developments, the results of the FY 1999 IST demonstration, and the anticipated threat. The NMD Integrated Deployment Plan (IDP) provides the capability for deployment of an initial capability in three years following the deployment decision. A Deployment Readiness IPT will develop the NMD IDP, which is a comprehensive and evolving document which provides "system focus" to deployment, integrates system elements, and maintains deployment planning status.

3.7.2 Deployment Schedule

BMDO will continue to conduct critical path analysis of the development and deployment schedules to identify time reduction opportunities, resource requirements, and risk areas.

3.7.3 Logistics

Logistics support is a series of activities that will be developed and procured in compliance with the BMDO-approved system support concept. The NMD Program will plan for and encourage the use of standard support and test equipment.

3.7.4 Facilities Siting and Environmental

BMDO is conducting facility, site, and National Environmental Protection Act (NEPA) work based on the North Dakota Area Siting Study for an ABM Treaty-compliant NMD system and has undertaken many studies to determine the potential consequences to the environment of its programs. BMDO is planning to complete an environmental analysis of nine alternative sites in FY 1999. At the same time, as required by NEPA, BMDO is using the DoD's Environmental Impact Analysis Process (EIAP) to integrate environmental considerations into its decision making and to establish the required timing and scope of environmental impact analysis documentation in support of program decisions.

Preliminary site activation planning is in process for a "prototype site," a combination of Grand Forks AFB, Stanley R. Mickelsen SAFEGUARD Complex (SRMSC), and Minot AFB, to prepare for the Deployment Decision Review. Early planning for site activation at such a site will allow the development of critical planning data and will greatly reduce deployment risk to an actual deployment site. Other site activation tasks include writing and executing a site activation plan, providing site facilities and infrastructure, installing and testing, and transition planning.

3.7.5 Suitability Assessment

The NMD Program will implement a comprehensive approach to ensure that human performance and resource considerations are appropriately and adequately addressed through the identification of risk areas and mitigation actions that conform to OSD policies and guidance.

In addition, BMDO will also incorporate a structured Reliability and Maintenance program built around the NMD systems engineering approach which eliminates specifying availability at the system level, relying rather on specifying system effectiveness. Operational availability will be addressed at the subsystem element level, in response to potential Joint ORD requirements designated at the element level.

3.7.6 Producibility and Manufacturing (P&M)

In early 1996, the updated BMDO P&M Strategy was issued, emphasizing innovative approaches, vision, strategies, tools, and risk reduction processes for P&M issues. A key element in this process is the P&M Program Integrated Product Team (P&M PIPT), established to address and resolve risks associated with transitioning BMD systems from development to production.

3.8 System Engineering and Integration (SE&I)

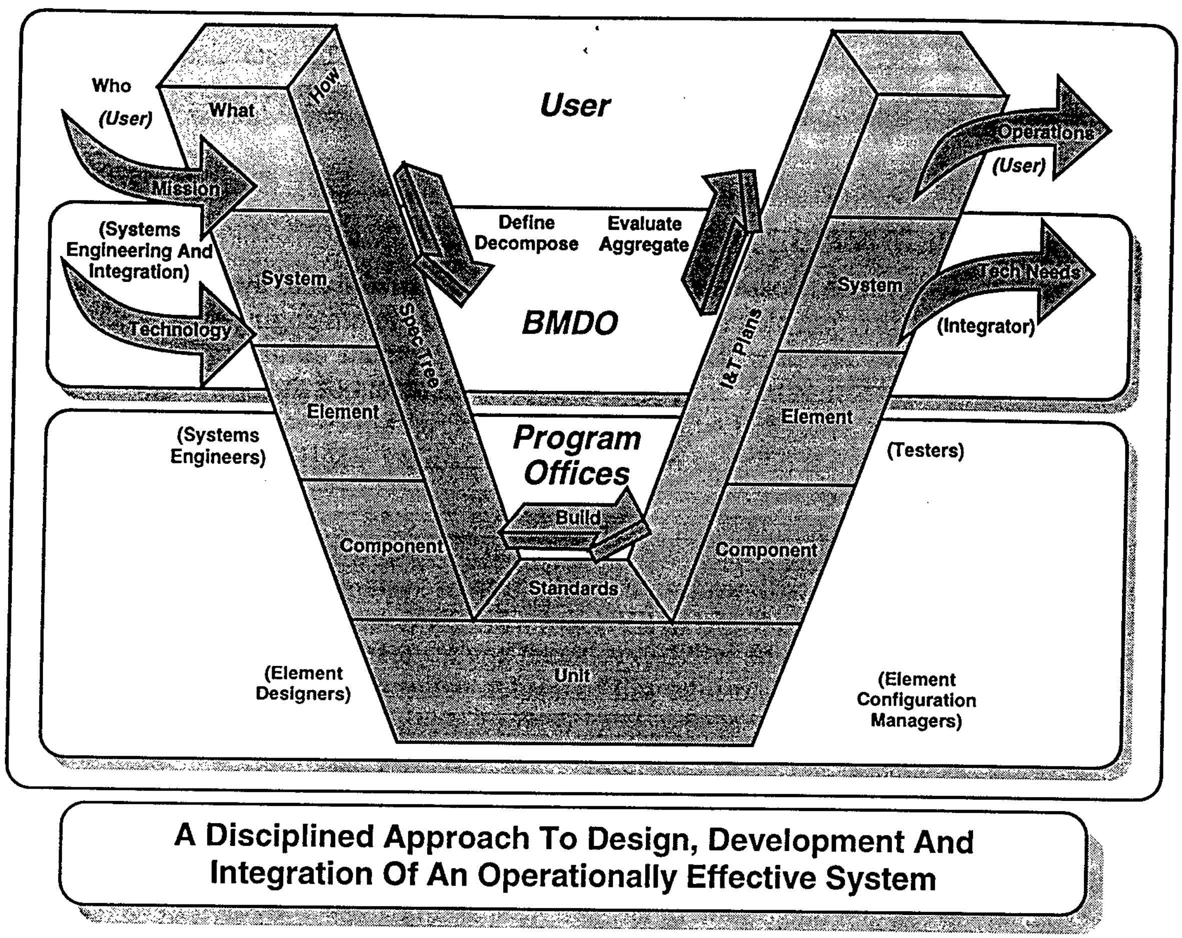
CRD performance and operational parameters for NMD are translated into system development parameters and allocated to system elements through the BMDO system engineering process (see Figure 3-10). Requirements are provided to the NMD development community in the NMD SRD. Further requirements definitions are provided for the elements of the NMD system in the Element Requirements Documents (ERDs). The NMD SE&I Program consists of activities necessary to establish the readiness to acquire an NMD system capability consistent with the SRD and ERDs.

NMD system engineering efforts will result in the definition of system/element test requirements for NMD flight testing scheduled to begin in FY 1997 with EKV seeker flight tests. As element and system tests are conducted, results will be evaluated against test predictions, system and element requirements. Where necessary, results will be used to adjust and modify element designs to rebalance the NMD system. Refining system-level derived requirements based on demonstrated tests will validate system element integration while ensuring interoperability and compatibility between NMD elements.

BMDO will execute an SE&I process with four principle objectives. One, SE&I will complete the necessary development and integration of an NMD Capability 1 "3+3" system to be ready for demonstration in FY 1999 based on the threshold requirements in the Joint ORD. Two, SE&I will establish the objectives and validate the results of the FY 1999 IST. Three, the SE&I process will produce incremental upgrades of the Capability 1 system on a path toward the Capability 2 system, consistent with the objective requirements in the Joint ORD. Finally, the SE&I process will enable fielding of the NMD system and subsequent upgrades.

Given the uncertain nature of the ballistic missile threat, the SE&I requirements strategy is designed to accommodate both the threshold and objective requirements by setting sights on the horizon and defining NMD system requirements for Capability 2 while going back and defining Capability 1 requirements which evolve directly to Capability 2, subject to element availability. This strategy rests on three strengths. One, it will provide for the efficient execution of NMD strategy. Two, it will permit requirements traceability to suit user needs. Three, this SE&I requirements strategy will meet user requirements for a rapidly deployable Capability 1 while providing for an efficient evolution from Capability 1 to Capability 2.

Figure 3-10. System Engineering And Integration In NMD



Chapter 4

Supporting Technology Development Strategy And Programs

Chapter 4
Supporting Technology Development Strategy And Programs

4.1 Technology Investment Strategy

The Ballistic Missile Defense (BMD) technology investment strategy for sustainable development is to acquire systems that meet today's requirements and, at the same time, to anticipate potential future BMD requirements and the technology needs of tomorrow. Accordingly, these BMD efforts concentrate on affordable, high payoff technologies, including those available through cooperative programs with our allies, that can:

- Enable and assure the continuing vitality and potential National Missile Defense (NMD) and Theater Missile Defense (TMD) improved performance;
- Demonstrate the technology base to defend against advanced threats such as maneuvering targets, straightforward countermeasures, advanced submunitions, and Weapons of Mass Destruction (WMD); and
- Offer alternate system approaches (architectural flexibility) that can provide major increases in TMD and NMD capability against the current and evolving threat.

In essence, BMDO is developing the technology essential to meet the BMD mission in future years. In accordance with Congressional direction, BMDO maintains the follow-on support technology programs for BMD. Advanced technology efforts that either directly support future TMD and NMD system developments, or hold significant promise for advanced BMD systems, remain under the management responsibility of BMDO.

4.2 Technology Needs

To maintain the viability of a BMD architecture over time, technologies being developed must provide options for improvements to deployed systems or replace those systems with new capabilities to respond to a range of needs. Among the most important of these needs are capabilities to:

- Meet straightforward countermeasures such as decoys or electronic countermeasures;
- Cope with threat evolution such as advanced submunitions that improve the effectiveness of the attacking missile, longer range missiles that enlarge the areas that can be attacked, and maneuvering and less observable targets;
- Cope with threat evolution that presents the United States with rapidly developing crisis situations where there is insufficient time to deploy short- and mid-range systems to a theater of operation, or with situations where there is no friendly territory or international waters suitable for deploying such systems; and
- Handle proliferation of ballistic missiles and an increasing number of countries possessing the technology for WMD. This proliferation demands greatly expanded battle

space, increases the potential for surprise, and leads to the need for rapid deployment of TMD to counter rapid escalation of a conflict, or for continuous global Boost Phase Intercept (BPI) coverage.

To prepare to meet these future needs, BMDO is investing in the high leverage technologies that can provide:

- The capability to intercept ballistic missiles in their boost phase of flight. Space Based Laser (SBL) technology could address all of these needs, as well as reduce the burden on midcourse and terminal-tier defenses. This is also the only advanced technology that could provide a continuous, global BPI defense;
- Highly effective and affordable concepts for executing boost phase intercepts of ballistic missiles using kinetic energy interceptors launched from high-altitude, long-endurance Unmanned Aerial Vehicles (UAVs);
- Exoatmospheric and endoatmospheric intercept capability with high probability of kill at reduced technical risk and program cost to expand battlespace, increase defended area coverage, and provide quick response solutions to theater defense;
- Multisensor detection and tracking that extends through the missile flight path to provide the earliest possible alert, and midcourse tracking; and
- Algorithm development for the identification, discrimination, aim point selection, and kill assessment to support early assured targeting and tracking within the battlespace environment, thereby achieving effective battle management.

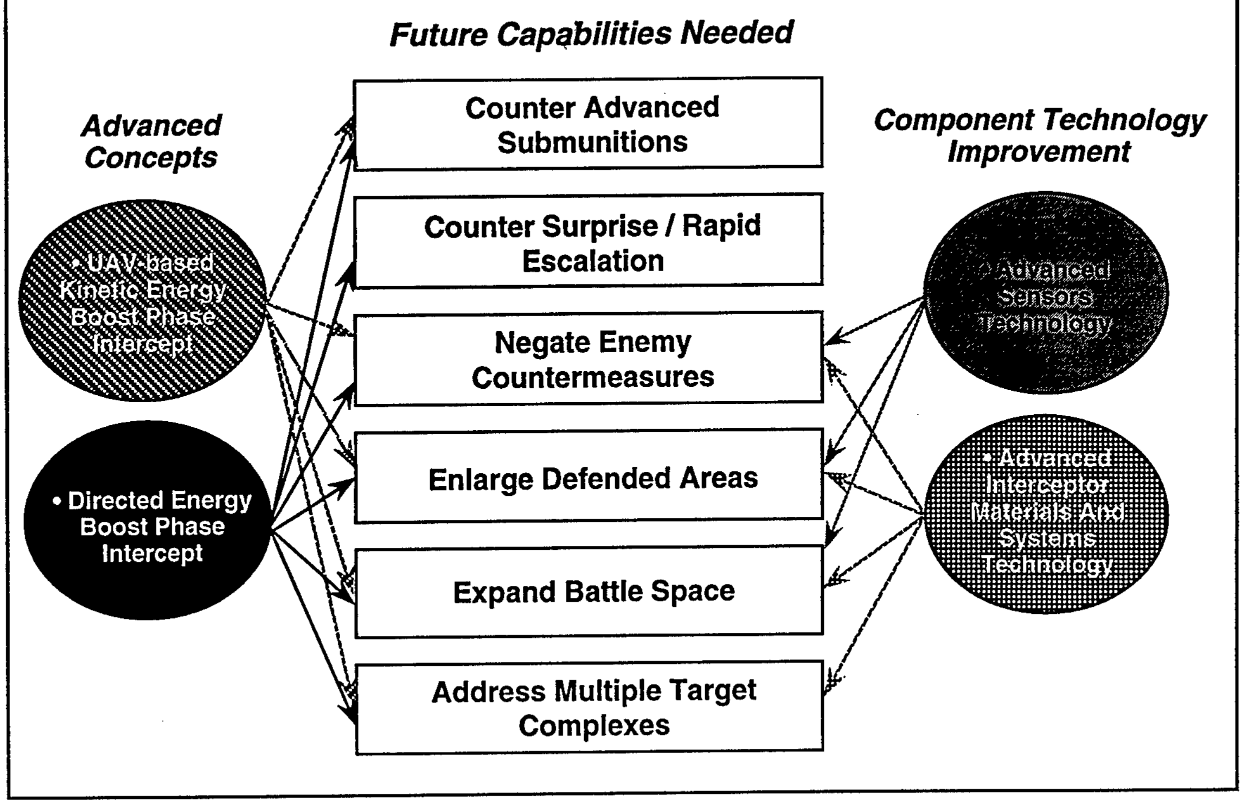
Figure 4-1 diagrams the future threat in terms of capabilities needed and potential technology solutions. Arrows point from each critical technology solution to the mission needs which that solution addresses.

4.3 Program Overview

The current advanced technology development program is structured in four major segments: UAV-based Kinetic Energy Boost Phase Intercept, Directed Energy Boost Phase Intercept, Advanced Sensor Technology, and Advanced Interceptor Materials and Systems Technology. Figure 4-2 provides the current schedule for each segment.

Early BPI of ballistic missiles reduces the number of ballistic missiles reaching their terminal phase of flight. Early BPI can cause missile debris to fall on enemy territory and any BPI will cause the missile to fall short of the intended targets. BPI could serve as a powerful deterrent against further development, proliferation, or actual use of chemical, biological, or nuclear warheads. The importance of BPI capability increases significantly as the range of the ballistic missile threat increases and the types of warheads proliferate. Intercept of a missile in its boost phase near the point of launch enables larger defended areas and simplifies the identification and discrimination problems associated with advanced submunitions, and threat penetration aids. The major objective of BPI programs is to demonstrate the required technologies in the relevant operational environment in order to establish system utility.

Figure 4-1. Technology Needs



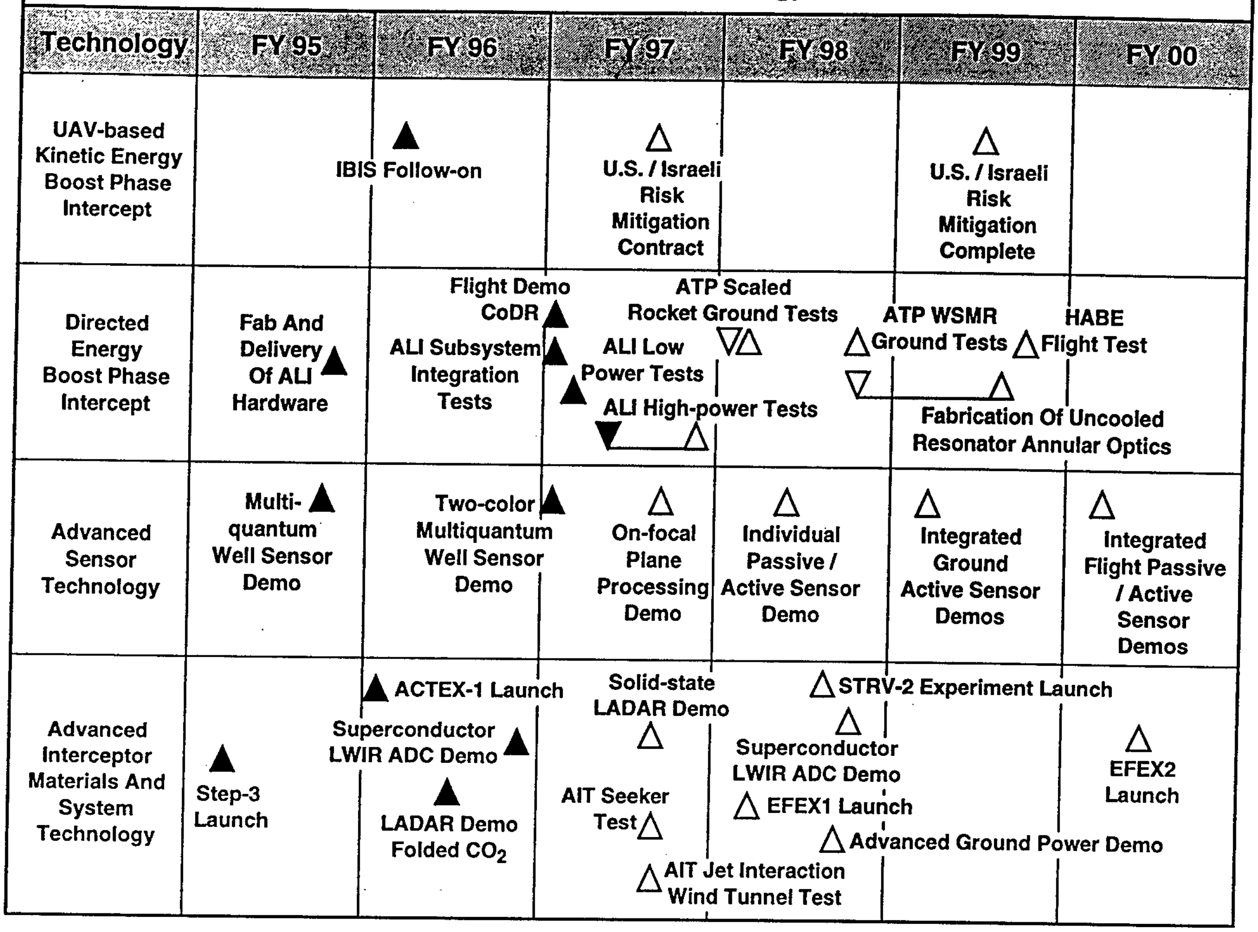
Continuous, global BPI coverage is essential for rapidly developing situations where there is insufficient time to deploy a short-range system to the theater or where geography and/or the political environment does not provide suitable territory or international waters for such a deployment.

4.3.1 Unmanned Aerial Vehicle (UAV)-based Boost Phase Intercept (BPI)

The UAV-based BPI program covers two efforts: Task 1 - Boost Phase Intercept System Risk Mitigation, and Task 2 - Cooperative UAV-based BPI Concepts. Both tasks are based on the Israeli Boost Phase Intercept System (IBIS) concept and support a cooperative U.S./Israeli risk mitigation initiative. Task 1 will refine (risk mitigate) the IBIS concept of unmanned aerial vehicles armed with kinetic energy interceptors to provide the means of destroying thrusting Theater Ballistic Missiles (TBMs) in their boost phase of flight. Task 2 will leverage off previous and ongoing U.S. investments in Infrared Sensors to develop an Infrared Search and Track (IRST) capability able to be deployed on a UAV BPI system. System components to be mitigated include kinetic energy interceptors, UAVs, search and track sensors, and Battle Management/Command, Control, Communications, Computers, and Intelligence (BM/C^4I). In addition, the Concept Of Operations (CONOPS) will be refined.

The program will develop and demonstrate critical technology elements to support UAV-based BPI concepts. The program will leverage existing contracts and technologies. Piece part demonstrations will validate critical technologies such as moderate velocity lightweight air-launched interceptors, a missile seeker head, and will provide (1) new component and system capabilities with reduced costs and risks compared to current weapon systems; (2) reduction of costs and risks

Figure 4-2. Advanced Technology Schedule



to support an acquisition program; and (3) technical solutions for contingent residual BPI capabilities for theater defense.

4.3.2 Directed Energy Boost Phase Intercept

The Directed Energy Boost Phase Intercept Program consists of the Space Based Laser (SBL) Program and the Acquisition, Tracking, Pointing and Fire Control (ATP/FC) program. These high-power chemical laser components and technologies were developed over the past 15 years specifically for the boost phase intercept mission. These two programs were restructured in FY 1996 to reflect Congressional and DoD guidance, which provided $45M of additional funding, as well as an additional $70M in FY 1997.

The major building blocks have been developed, but system integration and test lie ahead. The remaining tasks are to integrate the high-power laser with the large optics beam director and test in a ground demonstration Alpha/LAMP Integration (ALI); to integrate and test ATP/FC hardware and software onboard High Altitude Balloon Experiment (HABE); to integrate laser, beam control, and beam director hardware with ATP/FC hardware and test; and to integrate the hardware in a space-qualified SBL Readiness Demonstrator (SBLRD) vehicle for ground and flight testing.

In FY 1996 Congress provided additional program funding to continue ALI, accelerate design activities for a space demonstration, produce a CONOPS, design requirements for an operational SBL system, and revitalize the SBL technology development efforts. The $45M Congressional addition was released in April 1996, obligated within 60 days and fully expended by December 1996, allowing BMDO to preserve vital infrastructure, restore the ALI program to its original scope, and continue the ATP/FC program.

The current plans bring Alpha back to test readiness and, with Congress-added funding, completes ALI high-power tests in FY 1997. The Alpha device and facility have been reactivated and the test team reconstituted.

The ATP/FC program completed fabrication and test of the illuminator laser that will be used in the field experiments. Integration into the HABE platform was completed and testing begun. With the FY 1997 Congressional increase, integrated ground testing will be completed in early FY 1998, and the first flight test will occur in FY 1999.

4.3.3 Advanced Sensor Technology

This program is an evolutionary effort to improve tracking of ballistic missiles by improving surveillance sensors, and advancing signal processing techniques for efficient and definitive identification and discrimination. Development efforts emphasize compact, adaptable, efficient passive Focal Plane Arrays (FPA) and precision active optical ranger/illuminators. Integrated detection/signal processing demonstrations are scheduled for FY 1997.

Thereafter, the program develops the next generation of BMD sensing technology. Resources will also be used to develop data fusion and discrimination. Intermediate milestones address a building block approach of the system hardware and algorithm development. Ground testing of these integrated technologies will begin in FY 1998. The ultimate objective will be achieved in a FY 2001 flight, using available aircraft platforms, that will demonstrate fusion of surveillance sensor data from radar, Laser Detection And Ranging (LADAR), and Long Wavelength Infrared (LWIR) sensors with onboard signal processing, tracking, and discrimination algorithms. The Proof-Of-Principle (POP) detection, tracking, and discrimination demonstrations are planned to validate the maturity of technology prior to infusion into any acquisition program.

An effort related to the sensor program involves understanding the phenomenology associated with target signatures against different backgrounds. BMDO continues this critical technology program and has conducted a number of activities with our allies aimed at extending phenomenology databases through acquisition and exchange.

The Midcourse Space Experiment (MSX) satellite is BMDO's only on-orbit platform that couples a Low Wavelength Infrared/Very Low Wavelength Infrared (LWIR/VLWIR) sensor with state-of-the-art visible and ultraviolet sensors. It will provide high-fidelity optical data on target signatures and long duration global and seasonable background clutter data. Information from this program will mitigate design risk, enable optimal system design, and minimize life cycle cost of future systems (e.g., Space Based Infrared System (SBIRS)).

4.3.4 Advanced Interceptor Materials and System Technology (AIMST) Program

The AIMST program is based on the fundamental premise that technology investment is not an option but rather a requirement for achieving the BMDO mission. The focus of the program is therefore on providing technologies for BMDO elements which reduce technical risk, enhance capabilities, and increase affordability. Technology insertion is accomplished through extensive ground, airborne, and space demonstrations. Five major categories are addressed:

1. Technology which will ensure high signal/noise images for interceptor and surveillance optical sensors; active and passive vibration control and use of noncontaminating optical baffles and low noise superconducting signal processing electronics.

2. Development of lightweight, high stiffness, advanced composite structures and components which utilize low-cost, single-step fabrication methodologies to provide cost-effective weight growth mitigation for all BMDO system elements.

3. Provide essential data to BMDO systems which enable design of effective sensor, surveillance and interceptor systems. This includes data on performance of critical microelectronic components in the space radiation environment; Medium Wavelength Infrared (MWIR) background/ clutter data at high latitudes as a function of altitude and seasonal variation; micrometeorite and debris fluence at mission altitudes, response of key materials and coatings to the space environment, and basic engineering data on structural response and sensor window performance during ultrahigh-speed (>3 km/sec at 60 km altitude) endoatmospheric flight. BMDO tests on advanced materials for use in Infrared (IR) windows has included samples from several allied nations including the United Kingdom (U.K.) and Japan.

4. Development of interceptor components necessary to achieve long-range threat detection, accurate homing guidance, and aim point selection for hit-to-kill interceptors. This includes high-sensitivity, uniform passive infrared LWIR seekers, Laser Radar (LADAR), and data fusion processing technologies. Emphasis is placed on increasing output power, miniaturization, and waveform generation to support onboard imaging. The ultimate objective will be achieved in interceptor flight tests in FY 2002 that will demonstrate onboard fusion of active and passive data to detect, track, and discriminate. The POP demonstrations are planned to validate the maturity of the technology and to demonstrate the reduced dependence of interceptors on external sensors to perform hit-to-kill, prior to infusion into any acquisition program.

5. The Atmospheric Interceptor Technology (AIT) portion of the program will develop, integrate and demonstrate the kinetic kill vehicle technologies for performing hypervelocity hit-to-kill intercepts of TBMs within the atmosphere. The demonstrations will validate the solutions to critical kinetic kill vehicle technologies and will provide: (1) new capabilities with reduced costs and risks compared to current interceptor weapons systems, and enhancements to other interceptors under development; (2) reduction of technical risks and costs in support acquisition programs through direct technology insertions; and (3) technical solutions to provide theater defense interceptor capabilities for contingencies not currently addressed by the TMD system programs.

The program uses existing contracts and technologies currently under development to reduce schedule and cost, and will be planned and conducted with BMDO, Air Force, Navy, and Army elements to make maximum use of existing Service infrastructures. The AIT project will participate in the UAV/BPI Studies and the Navy Theater Wide requirements studies. As a result of a $40M plus-up in the appropriated funding level, AIT will conduct the following work in FY 1997:

- Complete prototype seeker development and conduct initial hardware-in-the-loop test;
- Conduct cooled window and forebody aero-optic shock tunnel tests;
- Conduct cold-gas jet interaction wind tunnel tests;
- Complete preliminary software specifications;
- Conduct System Requirements Review (SRR);
- Conduct preliminary of solid Divert and Attitude Control System (DACS) and deliver DACS Ground Test Unit;
- Complete integrated avionics unit final design;
- Fabricate and integrate vehicle structures;
- Conduct Preliminary Design Review (PDR) for flight test vehicle; and
- Conduct millimeter wave (RF) technology development.

The Atmospheric Interceptor Technology program has effectively leveraged the expertise and resources of other agencies and allied nations in collaborative multinational, multiagency programs. This approach minimizes direct cost to BMDO and increases the effectiveness of technology development and demonstration efforts.

4.4 BMD Exploratory Science and Technology Program

The goal of the Exploratory Science and Technology Program is to identify, nurture, develop, demonstrate, and transition innovative ideas and approaches to BMD technology. The projects sponsored by the program are structured to exploit science and technology to improve performance, weight and volume, producibility, and affordability of future BMD systems. Many examples of successful research, demonstration, and transition are already documented, while many new ones are in the pipeline.

The Exploratory Science and Technology Program has two major thrusts: The Innovative Science and Technology (IS&T) contracted research program, and the Small Business Innovation Research (SBIR) program. Unlike other BMDO projects that fund near-term technology and testing efforts, the IS&T program is an exploratory science and technology initiative that invests seed money in high-risk, potentially high pay-off technologies that could significantly change how BMDO develops future systems. Technologies include next generation sensors, power, information processing, optics, advanced materials, propulsion, and communication. A primary goal is to conduct proof-of-concept demonstrations that transition breakthrough technology to BMD devel-

opment programs. Planned and funded by BMDO, the bulk of the program is technically managed by Science and Technology Agents affiliated with defense and other government research agencies, with the principal investigators often coming from academia as well as industry.

4.5 Technology Transfer and Dual Use

Much of the research pursued by BMDO has broad application to meeting overall DoD needs and potential for civil and commercial applications. A second important objective is, therefore, to conduct a portion of the BMDO research efforts in a manner that enhances this technology transfer. For ten years, the Office of Technology Applications (OTA) within BMDO has focused on moving BMD technology out of the DoD and other Federal Laboratories and into the commercial market place and other agencies. It has been a model program, working closely with government, universities, and industry. To date, the OTA program documented the following statistics from its commercialization efforts: 45 new spin-off companies started, 234 new products on the market, 551 patents granted, 221 patents pending, 54 new ventures (licensing agreements, strategic alliances, third party agreements, partnerships, etc.), and started 33 cooperative research and development agreements. Each of these emanates from a BMDO-sponsored technology. Table 4-1 describes a sampling of BMDO research technologies and their dual use potential.

Often an initial investment of BMDO research and development funding is greatly leveraged by funding from other government or commercial sources. Activities of BMDO's SBIR are a case in point. Market capitalization, the high-tech small business community that the SBIR program supports, is considered just one of the metrics that can be utilized to measure the success of the program overall.

4.6 Significant Accomplishments in 1996

Some technology accomplishments for 1996 are briefly highlighted. The accomplishments are representative of BMDO's technology program and illustrate the broad spectrum of activities required to support TMD and NMD.

In the Solar Concentrator Array With Refractive Linear Element (SCARLET) program, the flight qualification for SCARLET I was completed. The next generation design, SCARLET II, was completed and 100 engineering prototypes of the 24% efficient flight solar cell were delivered.

In the Laser Communications (Laser Com) program, a successful mountaintop-to-mountaintop test was conducted, with a data rate of 1.2 Gbytes per second.

In the Russian Hall Effect Thruster Technology (RHETT) program, RHETT I was successfully ground demonstrated.

The MSX satellite was successfully launched from Vandenberg Air Force Base (AFB) on April 24, 1996. Within days it began collecting IR, visible, and Ultraviolet (UV) data on celestial, earthlimb, and hard earth backgrounds. In addition to several cooperative target data collections, the first MSX Dedicated Target (MDT-II) was successfully launched on August 31, 1996. MSX also suc-

Table 4-1. BMDO Technology Dual Use Potential

Research Area	Impact On BMD Capabilities	Potential For Military And Civilian Applications
Sensors		
• 150 Kelvin Cooler	• Mirror And Baffle Cooling Of Spacecraft Sensor	• Cooling For Electronic And Computer Systems
• Indium Antimonide Infrared Arrays	• Primary Sensor For Objective THAAD Missile	• Developed Into Infrared Detector For Civil, Safety And Law Enforcement IR Camera System
• Quantum Well Infrared Photodector (QWIP) Focal Plane Array (FPA)	• Higher Operability, Lower 1/f Noise, Higher Radiation Hardness And Less Than 5% Of The Cost Of HgCdTe Based FPAs	• Airborne And Spaceborne Warning Systems, Earth Observation Satellites, Pollution Monitoring
• Staring Si Impurity Band Conduction Extremely Sensitive Focal Plane Arrays (FPAs)	• FPAs Sensitive In The 4-25 Micron Region, High Sensitivity For Extended Range Sensing	• Incorporation Into NASA's Space Infrared Telescope Facility (SIRTF)
• Low Power, Lightweight 65K Cryocooler	• Long-term Time On-orbit Of Space And Missile	• Tactical Infrared Search And Tracking Systems, Cryogenic Computers, NASA Remote
Optoelectronic Devices		
• High-speed Photonic Networks	• High Performance Computing And Communications For Test And Evaluation, Simulation And Battle Management, Command Control And Communications (BM/C³)	• National Information Infrastructure (NII)
• Terabyte Optical Storage	• Archival Storage For Test Data	• Large Public Databases, Digital Libraries, Medical, Commercial Video, And Other Archival Storage Media
Electronic Devices		
• Nonvolatile Semiconductor Random Access Memory (RAM)	• Long Life Memory For Theater Operations	• Wireless Communications Smart Highways
• Low Temperature (10 degrees Kelvin) Digital And Analog Superconducting Circuits	• Transceivers For Broadband Wireless Backbones For Telecommunications, High-speed Switching For Command And Control Centers (e.g., MMIC)	• Multimedia Centers
Computers		
• WASP 3-D Wafer Scale "Associative String" Reconfigurable Processor	• Graphics Engine For BM/C³ And Test And Evaluation Workstation	• Visualization Engine For Multimedia
• 3-D Analog Neural Network Processor 3-DANN	• Compact (1 cubic inch) Low Power (1W) Fast Frame Seeker	• Powerful Neural Network Processor For Real-time Image Processing And Robotics Computation
• VIGILANTE - Sensor / Processor	• Investigates Real-time Detecting Tracking And Discrimination	• Teraflop Performance For Target Discrimination, Industry Feature Recognition
Communications		
• Laser Communications (LaserCom) 1 Gbps Transceiver	• High Capacity Jam-less Backbone For Sensor-to-Sensor Satellite Downlinks	• All Communication From Space And Between Satellites
• Miniaturized EHF Transceiver	• Wireless Communications Links For BM/C³ And Test And Evaluation	• International Teleconferencing
Materials		
• Wide Bandgap Semiconductors	• Demonstrated True Blue Laser Diode, SiC Nonvolatile Random Access Memories Designed GaN Microwave Amplifier	• Thin Screen Color Display, Permanent Memory At RAM Access Speeds, Reduced Weight And Volume For Ground Based Radar Power Supplies
• Multifunctional Structures	• Integrates Power Distribution, Electronics, And Damping With Structural Members To Reduce Weight And Volume	• Satellite/Interceptor Systems
• Successful Flight Of STRV-1 U.S. / U.K. Microsatellites	• Improved Sensor Performance Due To Reduced Noise	• DoD, NASA Applications For Low Mechanical Noise Platforms
Rocket Propulsion		
• Energetic Oxetane Thermoplastic Elastomers	• Propellant Manufacturing Defects Corrected By Reheating And Recasting, Waste And Reclaimed Propellant Reused Without Penalty	• Tri-Service Interest Building, Integral Part Of Several IR&D Programs
• High-G Solid Divert And Altitude Control Propulsion	• Navy Safe Propulsion For Hit-to-Kill Interceptor Systems	• Highly Maneuverable Missile Systems Inside Or Outside Atmosphere
• Flexseal Vectorable Nozzle	• Reduces Cost, Enhances Interceptor Hit-to-Kill Performance	• Thrust Vector Control For Commercial Launch Systems
Miniature Interceptor Technology		
• Small, Accurate IMUs, Miniature Sensor Set Testing, Miniature Propulsion	• Address Ballistic Missile Submunition Threat	• Addresses Tactical Missile Threat, Miniature IMUs Offer Low Cost Alternative To Civilian GPS Receiver
Power And Propulsion		
• RHETT Hall Electric Thruster	• Orbit Insertion, Faster Orbital Repositioning	• Orbit Insertion, Station Keeping For Satellites, Cooperative Program With Navy
• Solar Array Technology That Includes Concentrators And Dual Bandgap Photovoltaic Materials	• 40% Reduction In Mass, 60% Reduction In Cost, Resistant To Van Allen Radiation	• Cooperative Program With NASA Flight Demonstration Tests Being Augmented By Communication Satellite Companies

cessfully tracked and collected data on four aircraft missions and several Resident Space Objects (RSOs), including the space shuttle. Throughout 1996, the MSX program transferred lessons-learned and technology information to the SBIRS community.

In the Directed Energy program, a high-power reactivation test of the Alpha laser device was successfully completed in September 1996 after being placed in an inactive/maintenance-only mode for over two years.

In ALI, all major assemblies were fabricated, integrated, and tested in the test chamber. In December 1996 an Alpha hot flow test was conducted while performing a low-power integration check-out of the ALI beam train. In compliance with Congressional language, design activities for the follow-on space qualified vehicle ground demonstration were restarted, and the Cost Analysis Requirements Document (CARD) was updated with emphasis in the CONOPS, user design requirements, satellite design, and launch vehicle design. Design reviews for the demonstrator space vehicle and operational SBL system concepts occurred in December 1996. The SBLRD test facility site selection process was restarted. The facility design, site selection, and preliminary environmental assessment for the Space Test Facility will be completed in FY 1997. Design activity for the SBLRD is continuing.

The Russian cooperative technology programs have been progressing. In August 1996, the Russian Government agreed to continue the Russian-American Observation Satellite (RAMOS) program. The Russian Space Industrial Company, NPO *Cometa*, under the auspices of *Rosvoorzhenie*, the Russians Arms Import/Export Agency, agreed to a number of satellite stereo viewing observations. In addition, several innovative aircraft and space sensor projects will be explored with Russia. In the Active Geophysical Rocket Experiment (AGRE), beacons for the U.S. MSX satellite were integrated onboard two Russian MR-12 sounding rockets, and were launched in January-February 1997 out of the Kapustin Yar range. MSX will observe the launches and high-altitude plasma cloud generated by the Russian's experimental payload.

In the AIT program, cooled window and forebody aero-optical shock tunnel tests were conducted, as well as forebody and airframe vibration tests and field joint validation.

Chapter 5

Program Funding

Chapter 5
Program Funding

5.1 Funding Summary

BMDO submitted the FY 1998 President's Budget in accordance with the Congressional instructions set forth in the FY 1997 National Defense Authorization Act. This report reflects several changes that occurred in FY 1997 and are proposed for FY 1998. First, NMD became a deployment readiness program. Consequently, NMD deployment readiness projects were organized and funded in the 2400 series. Second, the Department of Defense implemented several decisions that affected BMDO funding, including adjustments to the THAAD, Navy Theater Wide, and SBIRS programs. Another decision transferred BMDO procurement funding to the Services. Beginning in FY 1997, management support costs are allocated to specific BMD projects.

A composite funding perspective, combining all project funding, has also been provided as part of the budget justification materials. Figure 5-1 summarizes the total program funding by Program Element (PE). Figure 5-2 lists the current projects and provides a funding summary by project. Appendix B provides a narrative description of the activities planned, recent accomplishments, and funding plans for each project. The Congressional Descriptive Summaries (CDS) provided in support of the FY 1998 President's Budget request describe this information in greater detail.

Figure 5-1. Program Element Summary
(In Millions Of Then Year Dollars - Rounded)

Project Number And Title		FY 1997 Request	FY 1997 Appropriated	FY 1997 Current Estimate	FY 1998 Request	FY 1999 Programmed
PE 0603861C / 0604861C						
THAAD System						
2260 THAAD	RDT&E	482	622	619	556	595
	MILCON	0	0	0	5	0
	Total	482	622	619	561	595
PE 0208863C						
HAWK						
2358 HAWK System BM/C^3						
	Proc	19	19	15	0	0
	Total	19	19	15	0	0
PE 02028865C / 0604865C						
PATRIOT Advanced Capability-3 Missile						
2257 PATRIOT	RDT&E	382	382	381	206	101
	Proc	215	215	219	351*	372*
	Total	597	597	600	206	101
PE 0208867C / 0603867C / 0604867C						
Navy Area Missile Defense						
2263 Sea Based Area Defense						
	RDT&E	302	302	301	268	227
	Proc	9	9	9	15*	45*
	Total	311	311	310	268	227
PE 0603868C						
Navy Theater Wide Missile Defense						
1266 Sea Based Theater Wide						
	RDT&E	58	304	304	195	192
	Total	58	304	304	195	192
PE 0603869C						
Corps Surface-to-Air Missile						
2262 MEADS (Formerly Corps SAM)						
	RDT&E	56	56	56	48	10
	Total	56	56	56	48	10
PE 0603870C						
1292 UAV BPI						
	RDT&E	**	24	23	13	0
	Total		24	23	13	0

* Procurement Funding Transferred To The Services. Not Included In Total PE or BMDO Funding.
** Funds Requested Under PE 0603872C

Figure 5-1. Program Element Summary (Cont'd)
(In Millions Of Then Year Dollars - Rounded)

Project Number And Title	FY 1997 Request	FY 1997 Appropriated	FY 1997 Current Estimate	FY 1998 Request	FY 1999 Programmed
PE 0603872C / 0208864C					
Joint TMD Activities (RDT&E Except As Noted)	***				
1155 Phenomenology			31	38	39
1161 Advanced Sensor Technology			3	3	3
1170 TMD Risk Reduction			23	35	25
1294 UAV / BPI			1	0	0
2160 TMD Existing System Mods			22	12	13
2259 Israeli Cooperative Projects			44	39	39
3153 Architecture Analyses / BM/C^3 Initiatives			7	8	8
3157 Environment, Siting And Facilities					
RDT&E			6	4	3
MILCON			1	2	2
3160 TMD Readiness			2	2	2
3251 Systems Engr And Tech Supp			51	65	62
3261 BM/C^{3}I Concepts					
RDT&E			32	34	36
Procurement			20	20*	26*
3265 User Interface			14	15	22
3270 Threat And Countermeasures			21	28	29
3352 Modeling And Simulations			64	73	73
3354 Targets Support			23	28	19
3359 System Test And Evaluation			43	40	26
3360 Test Resources			36	31	30
4000 Operational Support			83	87	85
Subtotal RDT&E	520	526	506	542	514
Subtotal MILCON	1	1	1	2	2
Subtotal Procurement	20	20	20	20*	26*
Total	541 (Includes MILCON & BM/C^{3}I)	546 (Includes MILCON & BM/C^{3}I)	527	544	516
PE 0603871C					
2400 National Missile Defense	****	****			
Subtotal RDT&E	508	833	829	504	393
Subtotal MILCON	0	0	0	1	13
Total	508	833	829	505	406

* Procurement Funding Transferred to the Services. Not Included In Total PE or BMDO Funding.
*** Redefined Project Structure
**** During FY 1997, NMD Became A Deployment Readiness Program Consisting Of The 2400 Series Projects Previously Encompassed By 1151, 1155, 1267, 1460, 3152, 3153, 3157, 3160, 3265, 3270,3352, 3359, 3360, And 4000

Figure 5-1. Program Element Summary (Cont'd)
(In Millions Of Then Year Dollars - Rounded)

Project Number And Title	FY 1997 Request	FY 1997 Appropriated	FY 1997 Current Estimate	FY 1998 Request	FY 1999 Programmed
PE 0602173C / 0603173C					
Support Technologies (RDT&E)	***	***			
1155 Phenomenology			18	27	26
1161 Advanced Sensor Technology			33	24	23
1270 Advanced Interceptor Materials And Systems Technology			68	31	29
1360 Directed Energy Programs			96	29	28
1651 IS&T			58	51	50
1660 Statutory And Mandated Programs			52	55	50
3352 Modeling And Simulation			2	2	2
4000 Management Support			27	30	32
Total	226	366	354	249	240
Subtotal BMDO Funding	2,798	3,653	3,637	2,589	2,287
Subtotal BMDO-Related Procurement	0	0	0	386	443
Total BMDO-Related Funding	2,798	3,653	3,637	2,975	2,730

*** Redefined Project Structure

Figure 5-2. Current Project Funding Profile (In Millions Of Then Year Dollars)

Project Number And Title		Funds Through FY 1996	FY 1997 Current Estimate	FY 1998 Request	FY 1999 Programmed
1155	Phenomenology	223	69	79	78
1161	Advanced Sensor Technology	145	36	27	26
1170	TMD Risk Reduction	80	23	35	25
1262	MEADS	95	56	48	10
1266	Navy Theater Wide Defense	356	304	195	192
1270	Advanced Interceptor Materials And Systems Technologies	64	68	31	29
1294	UAV BPI	6*	24	13	0
1360	Directed Energy Programs	192	96	29	29
1651	Innovative Science And Technology	818	58	51	50
1660	Statutory And Mandated Programs	390	52	55	50
2160	TMD Existing System Modifications	56	22	12	13
2257	PATRIOT (Includes Risk Reduction)	2,604	600	206	101
2259	Israeli Cooperative Projects	284	44	39	39
2260	THAAD	2,457	619	561	595
2263	Navy Area Defense	663	310	268	227
2358	HAWK System BM/C^3	98	15	0	0
2400	National Missile Defense (Includes NMD MILCON)	1,682**	829	505	406

* New Project For FY 1996
** During FY 1997, NMD Became A Deployment Readiness Program. Includes Funds From NMD Technology Readiness Program

Figure 5-2. Current Project Funding Profile (Cont'd)
(In Millions Of Then Year Dollars)

Project Number And Title		Funds Through FY 1996	FY 1997 Current Estimate	FY 1998 Request	FY 1999 Programmed
3153	Architecture Analysis / BM/C^{3}I Initiatives	36	9	11	11
3157	Environment, Siting and Facilities	48	7	6	5
3160	TMD Readiness	22	2	2	2
3251	Systems Engineering And Technical Support	128	51	65	62
3261	TMD BM/C^{3}I (BM/C^{3}I Concepts)	120	52	34	36
3265	User Interface	50	14	15	22
3270	Threat And Countermeasures Program	88	29	29	30
3352	Modeling And Simulations	285	99	97	97
3354	Targets Resources	173	23	28	19
3359	System Test And Evaluation	124	43	40	26
3360	Test Resources	124	47	42	41
4000	Operational Support	2,453	143	149	149
	Total:	13,864	3,637	2,589	2,287

Chapter 6

ABM Treaty Compliance

Chapter 6
ABM Treaty Compliance

6.1 Introduction

The 1972 Anti-Ballistic Missile (ABM) Treaty addresses the development, testing, and deployment of ABM systems and components. It should be noted that use of the word "research" does not appear in the ABM Treaty and research is not constrained by the Treaty. Neither the United States nor the Soviet delegation to the Strategic Arms Limitation Talks (SALT I) negotiations chose to place limitations on research, and the ABM Treaty makes no attempt to do so. The United States has traditionally distinguished "research" from "development" as outlined by then-U.S. delegate Dr. Harold Brown in a 1971 statement to the Soviet SALT I delegation. Research includes, but is not limited to, concept design and laboratory testing. Development follows research and precedes full-scale testing of systems and components designed for actual deployment. Development of a weapon system is usually associated with the construction and field testing of one or more prototypes of the system or its major components. However, the construction of a prototype cannot necessarily be verified by national technical means of verification. Therefore, in large part because of these verification difficulties, the ABM Treaty prohibition on the development of sea-based, air-based, space-based, and mobile land-based ABM systems, or components for such systems, applies when a prototype of such a system or its components enters the field testing stage.

6.2 Existing Compliance Process for BMDO

The Department of Defense (DoD) has in place an effective compliance process (established with the SALT I agreement in 1972) under which key offices in DoD are responsible for overseeing BMD compliance with all the United States arms control commitments. Under this process, the Ballistic Missile Defense Organization (BMDO) and DoD components ensure that the implementing program offices adhere to DoD compliance directives and seek guidance from offices charged with oversight responsibility.

Specific responsibilities are assigned by DoD Directive 2060.1, July 31, 1992, "Implementation of, and Compliance With, Arms Control Agreements." The Under Secretary of Defense (Acquisition & Technology) (USD(A&T)), ensures that all DoD programs are in compliance with the United States arms control obligations. The Service Secretaries, the Chairman of the Joint Chiefs of Staff, and agency directors ensure the internal compliance of their respective organizations. The DoD General Counsel provides advice and assistance with respect to the implementation of the compliance process and interpretation of arms control agreements.

DoD Directive 2060.1 establishes procedures for ensuring the continued compliance of all DoD programs with existing arms control agreements. Under these procedures, questions of applicability of specific agreements are to be referred to the USD(A&T) for resolution on a case-by-case basis. No project or program which reasonably raises a compliance issue can enter into the testing, prototype construction, or deployment phase without prior clearance from the USD(A&T). If

such a compliance issue is in doubt, USD(A&T) approval is sought. In consultation with the office of the DoD General Counsel, Office of the Under Secretary of Defense (Policy), and the Joint Staff, USD(A&T) applies the provisions of the agreements as appropriate. DoD components, including BMDO, have established internal procedures and offices to monitor and ensure internal compliance and periodically certify internal compliance to the Office of the Secretary of Defense.

In 1985, the United States began discussions with allied governments regarding technical cooperation on BMD research. To date, the United States has concluded bilateral BMD research Memoranda of Understanding (MOU) with the United Kingdom, Germany, Israel, Italy, and Japan. All such agreements will be implemented consistent with the United States' international obligations including the ABM Treaty. The United States has established guidelines to ensure that all exchanges of data and research activities are conducted in full compliance with the ABM Treaty obligations not to transfer to other states ABM systems or components limited by the Treaty, nor to provide technical descriptions or blueprints specially worked out for the construction of such systems or components.

6.3 BMDO Experiments

All BMDO field tests reasonably raising treaty compliance issues must be approved for treaty compliance determinations through the DoD compliance review process. The following major programs and experiments, all of which involve field testing, have been approved and either were conducted during FY 1996 or will be conducted during FY 1997: flights in the Airborne Surveillance Testbed (AST) program, a revision of the Airborne Optical Adjunct (AOA) project; High Altitude Balloon Experiments (HABE); the Midcourse Space Experiment (MSX); AEGIS SPY-1 radar and Standard Missile (SM-2 Block IV) modifications (Navy Area Defense Program); HAWK and TPS-59 radar upgrades; Miniature Sensor Technology Integration (MSTI) Satellite Development Program MSTI-3; PATRIOT PAC-3/ERINT system EMD flight tests; Theater High Altitude Area Defense (THAAD) interceptor Program Definition/Risk Reduction (PD/RR) flight tests 7-11; Endoatmospheric Aerothermal Mechanics Flight Test Experiments (EFEX); Resident Space Objects Rehearsal; Space Technology Research Vehicle 2 Mission (STRV-2) (FY 1998); Stinger With Optimized Radar Distribution (SWORD) program; Space and Missile Tracking System (SMTS) (formerly Brilliant Eyes) Flight Demonstration System (FDS) (FY 1998-99) and THAAD User Operational Evaluation System (UOES) System and Engineering and Manufacturing Development (EMD) program (includes interceptor and Theater Missile Defense-Ground Based Radar (TMD-GBR)); Cape Cod PAVE PAWS Doppler Discrimination Experiment; and National Missile Defense (NMD) Development Readiness Program Integrated Flight Tests 1-2 (Involving Exoatmospheric Kill Vehicle (EKV) Sensor Flight Tests). Compliance guidance has been provided for the Israeli Arrow interceptor development program known as the Arrow Continuation Experiments (ACES).

In addition, the following data collection activities are approved: High Altitude Observatory (HALO) aircraft; Cobra Judy; Theater Missile Defense Critical Measurements Program (TCMP) II (FY 1997) and III (FY 1998); Russian-American Observation System (RAMOS); Countermeasures Skunkworks Mission flight-tests 7-10; Active Geophysical Rocket Experiment (AGRE);

Glory Trip 160 and 162 Target of Opportunity checkout tests; Glory Trip 21 rehearsal; Glory Trip 22 PA; Red Tigress III; TMD SITs 96-1A, 96-1B, and 97-1, and the TMD C^3 program.

The following projects are approved activities that are not considered to be in field testing: Alpha/LAMP Integration (ALI) and the High Energy Laser System Test Facility (HELSTF) experiments and data collection activities. Also, the Joint National Test Bed (JNTB) including the Experiment Control Center (ECC) has been determined to be compliant with the ABM Treaty.

The following target development projects have been approved: Multi-Service Launch System (MSLS); Strategic Target Systems (STARS); Storm Targets (STORM II/Maneuvering Tactical Target Vehicle (MTTV)); Hera Target Vehicle; and the short-range Air Drop Target. All BMDO launches are reviewed for compliance with the research and development launch provisions of the 1987 Intermediate-Range Nuclear Forces Treaty. The Nuclear Risk Reduction Center of the Former Soviet Union (FSU) will be notified of such launches, as required.

Changes to the above approved experiments and programs are required to be reviewed for compliance implications.

The following programs, some of which have not been sufficiently defined for compliance certification, have not yet been determined to be treaty compliant: Medium Extended Air Defense System (MEADS) (also known as the Corps Surface to Air Missile (Corps SAM)); Airborne Laser Program (ABL); Exoatmospheric Kill Vehicle (EKV) flight tests (FY 1998-2000) (formerly the Ground Based Interceptor); Ground Based Radar Prototype (GBR-P) RTD program and the Long-range Air Launch Target.

The NMD deployment readiness program will be conducted in compliance with the ABM Treaty. Depending on its configuration, a deployed NMD system could either be compliant with the ABM Treaty as written, or might require amendment of the treaty's provisions.

Chapter 7

International Coordination And Consultation

Chapter 7
International Coordination And Consultation

7.1 Introduction

As a result of past participation in Theater Missile Defense (TMD) programs, global proliferation of ballistic missiles, lessons-learned from the Gulf War, and allied politico-military consultations and discussions, there is greater recognition among our friends and allies of the existing and emerging threat of ballistic missile attack and the need for the development of effective missile defense systems. Multilateral studies and activities in the North Atlantic Treaty Organization (NATO) Alliance and in unilateral actions by individual nations demonstrate the increased commitments to TMD.

7.2 Allied Consultations and Participation in Ballistic Missile Defense Programs

The Department of Defense approach to international participation in the development and deployment of TMD systems continues to build upon consultations with our allies and the establishment of bilateral and multilateral Research and Development (R&D) programs. Over the past ten years, our allies have contributed over $250 million through cooperative programs which are directly related to the U.S. Ballistic Missile Defense (BMD) program, including Theater Missile Defense (TMD). These cooperative R&D programs not only brought highly advanced technologies from abroad, but they also provided our allies with added insights with which to make informed decisions regarding their own missile defense requirements. The United Kingdom (U.K.) and Japan are currently involved in studies to determine their national BMD requirements and policy.

In an effort to achieve economies in the use of national resources and improving point defense of vital assets and maneuver forces, Germany, Italy, and the United States have agreed to cooperate on the joint development of the Medium Extended Air Defense System (MEADS). The codevelopment program, which was agreed for inclusion in the NATO structure, will be based on a commonly agreed military requirement, and to the maximum extent will capitalize upon technology existing in the participant nations. A Memorandum of Understanding (MOU) covering the Project Definition/Validation (PD/V) phase of the program was signed in May 1996. When fielded, MEADS will provide the three nations, and potentially other NATO nations, with a highly transportable, low-to-medium altitude, air and missile defense system against a variety of tactical missile and air breathing threats.

Consistent with Congressional urging, the United States has taken the initiative within NATO to forge an Alliance-wide consensus on the need for ballistic missile defenses -- defenses that contribute significantly to Alliance efforts to deter and defend against the proliferation of weapons of mass destruction and their associated delivery systems. Several NATO bodies are engaged in complementary TMD activities including, inter alia, development of a policy framework, Military Operational Requirement (MOR), Extended Air Defense Conceptual Framework, and approaches

and mechanisms for defining opportunities and methods of cooperation and/or collaboration in the TMD area. This latter area falls under the responsibilities of the Conference of National Armaments Directors (CNAD) which has established two NATO ad hoc groups. The first group explored opportunities for cooperation in the development and deployment of theater missile defenses whereas the follow-on ad hoc group focuses on Battle Management/Command, Control, and Communications (BM/C^3) and the development of technical systems configurations and associated costs.

7.3 Selective Status of Nations and NATO

7.3.1 *United Kingdom (U.K.)*

Since 1985, the United States has been actively involved with the U.K. on a variety of mutually beneficial BMD data exchanges, scientist and engineer exchanges, joint studies, trials, and experiments under an overarching MOU. The U.S. and U.K. are presently involved in a cooperative technology demonstration program involving the U.K. Multifunction Electronically Scanned Aperture Radar (MESAR) and early warning system experiments. The U.K. investments in these and similar programs, studies, and trials for over ten years now, have led to a strong relationship with the U.K. defense establishment and industry on BMD issues.

In addition to their long-term support of our cooperative activities in BMD R&D, the U.K. has concluded a 14-month Pre-Feasibility Study (PFS) to determine its national BMD requirements, including protection of its military forces abroad. The PFS and its associated studies have been presented in a report to ministers, and a policy decision regarding BMD systems development will be forthcoming.

7.3.2 *Germany*

The United States and Germany have long enjoyed a close, cooperative relationship in air defense activities since 1989. This relationship is being further advanced through cooperative efforts in TMD. In addition to its participation in the MEADS program, Germany is proceeding toward PATRIOT PAC-3 upgrades through Configuration 3. The United States and Germany have an ongoing cooperative program to enhance interoperability between their respective air defense tactical operations centers and in July 1996 entered into an agreement to conduct joint test bed experiments and analyses.

7.3.3 *France*

As a result of the 1994 Defense Ministry White Paper, France initiated an aggressive five year technology development program in BMD to be carried out indigenously and in cooperation with other NATO nations. Although the French government was not prepared to make a financial committment to MEADS, France has shown interest in participating with the United States in other areas such as early warning, Battle Management/Command, Control, and Communications (BM/C^3), phenomenology research, and extended air defense simulation modeling.

7.3.4 *Italy*

Italy is but one of a few NATO countries currently within range of North African tactical ballistic

missiles. Italy's vulnerability to ballistic missile attack was underscored by Libya's Scud missile attack against the Italian island of Lampudusa in the 1980s. The incident provided Italy the impetus for exploring replacement of its I-HAWK weapon systems, which culminated in Italy joining the United States and Germany in the MEADS codevelopment program. The Italian Ministry of Defense (MoD) is currently working on a comprehensive plan for air and missile defense that addresses both the threat and proposed architectures.

7.3.5 The Netherlands

The Netherlands has been a particularly active participant in NATO's extended air defense improvement efforts. It is studying requirements with a view toward possible purchase of PAC-3 for its operational PATRIOT systems and is in the process of acquiring the U.S. Extended Air Defense Simulation (EADSIM) modeling tool. The Netherlands has also expressed interest in the Navy's planned Standard Missile Block-IVA developments for inclusion in their next generation air defense Frigate 2000.

7.3.6 NATO

NATO's policy supporting an Alliance TMD capability is steadily developing. It began in the early 1990s with an appreciation of the risks posed to the Alliance by the proliferation of Weapons of Mass Destruction (WMD) and their delivery means among rogue nations to the south and east of NATO's periphery. NATO's new Strategic Concept recognized the necessity for protecting NATO's deployed military forces, territory, and population against ballistic missiles with WMD. An integrated NATO concept for extended air defense encompasses the need to defend against combined threats consisting of air breathing vehicles, tactical aerodynamic missiles, and ballistic missiles, and an MOR for Active Theater Ballistic Missile Defense has been prepared by NATO's major commands (Supreme Allied Command, Europe (SACEUR) and Supreme Allied Command, Atlantic (SACLANT)). More recently, NATO Defense Ministers have endorsed the Senior Defense Group on Proliferation (DGP) Phase I Report, which found that extended air defense, including Tactical Ballistic Missile (TBM) defense, was an essential component of NATO's response to the proliferation risk, and that the CNAD should develop options for pursuing a layered defense for NATO's deployed forces and report back to the North Atlantic Council.

The CNAD established an Extended Air Defense/Theater Missile Defense Ad Hoc Working Group (EAD/TMD AHWG) in 1993, composed of interested nations with resources to contribute, to examine mechanisms and opportunities for cooperation on ballistic missile defense. This group completed its work in 1995 and submitted its report that identified 19 possible areas for cooperation in TMD, provided an initial plan for proceeding with sensor, weapon, and BM/C^3 activities and, finally, recommended a follow-on group be established to (1) specifically examine requirements and ways to cooperate/collaborate on missile defense BM/C^3 and (2) develop technical systems configurations for TMD including associated costs. The CNAD endorsed these recommendations and a Missile Defense Ad Hoc Group (MDAHG) was established. The MDAHG, composed of 14 nations, has been given two principal remits: (1) provide an initial focus on TMD BM/C^3 for the CNAD, and (2) develop a range of technical configurations and associated cost estimates to inform NATO's Senior DGP who have the task to identify Alliance counterproliferation shortfalls, including TMD, and who will recommend approaches to the North Atlantic Council on how to address these shortfalls.

7.3.7 Israel

Israel has been actively involved in cooperative missile defense programs with BMDO since 1987. Because of the rapidly paced ballistic missile threat in the region, Israel was the first allied nation to declare its intent to field a missile defense system as a national priority. Cooperative activities have included: architecture studies; participation in several technology experiments; test bed development, enhancements, and experiments; examination of boost phase intercept concepts; and the development of the Arrow interceptor. The ongoing Arrow Continuation Experiments (ACES) began in July 1991. With the successful intercept of a target missile in June 1994, and validation of the preprototype design, the Arrow program progressed into the development and testing of the downsized, two-stage Arrow 2. The first flight test of the Arrow 2 on July 30, 1995, successfully demonstrated the interceptor's propulsion system and aerodynamic controls. The second flight test on February 20, 1996, successfully demonstrated the Arrow 2's focal plane array and booster motor. Its first intercept flight test on August 20, 1996, resulted in a successful intercept of a target missile. Three more tests of the Arrow II design are planned for the remainder of the ACES Program, which is planned for completion in 1997.

In parallel with the cooperative ACES program, Israel pursued development of the Arrow Fire Control Radar, Launch Control Center, and Fire Control Center with its own funding. Because of the progress in these Israeli programs and the anticipated success of the cooperative ACES program, Israel committed to the near term deployment of an active theater missile defense system. The Department of Defense (DoD) and Israeli Ministry of Defense (IMoD) negotiated and on March 29, 1996, signed the Arrow Deployability Program (ADP) agreement.

The ADP agreement provides for the integration, test, and evaluation of the Arrow Weapon System (AWS), namely, the jointly developed Arrow interceptor and Israeli-developed Fire Control Radar, Launch Control Center, and Fire Control Center. An interface will be developed for interoperability between the AWS and U.S. theater missile defense systems. Lethality, kill assessment, and producibility will also be jointly examined.

BMDO and IMoD are discussing a follow-on study to a joint boost phase intercept study that was completed in January 1996. The follow-on study would further the boost phase intercept concept developed by Israel and provide the United States unique data for analyses, lessons- learned, and technology risk mitigation.

7.3.8 Japan

Regional activity in response to the threat from tactical ballistic missiles, highlighted by the ongoing North Korean missile program and last year's increased China-Taiwan tensions, have heightened Japanese public and official awareness of TMD issues. Reflecting this awareness, the U.S.-Japan Bilateral Study on Ballistic Missile Defense, currently scheduled to be completed by summer 1997, will help support a decision by Japan on TMD. To support the study, the United States provides defense system performance and threat information to Japan to assist it in making an informed decision. Additionally, the overarching U.S.-Japan TMD Working Group continues meetings aimed at sharing information on general TMD issues.

Other significant TMD-related issues center on the continued Japanese licensed production and

deployment of the upgraded version of PATRIOT (PAC-2) and the recent commissioning of the third of four programmed AEGIS class destroyers. Additionally, Boeing Aircraft Corporation is currently producing E-767 Airborne Warning and Control System (AWACS) aircraft to be provided to Japan via the Foreign Military Sales Program.

7.3.9 Australia

Australia and the United States have established a modest program of cooperation that focuses on activities which reflect common interests in preventing the proliferation of weapons of mass destruction and affording protection from missile attack. As a result of the March 1994 U.S.-Australia Ministerial talks and the 1994 Australian Defense White Paper, a cooperative project involving sensor/data fusion testing was conducted at the Woomera Missile Range in October 1995. A more expansive experiment is scheduled for September 1997.

7.3.10 Russia

BMDO is involved in a number of technology cooperation projects with Russia. Several programs and experiments are planned or underway. The Russian-American Observational Satellite (RAMOS) program is a potential future joint project which will use both U.S. and Russian sensor platforms and sensors for stereo imaging. The joint Active Geophysical Rocket Experiment (AGRE) program - another project with Russia - investigated the effects of an explosive plasma jet on the ionosphere and evaluated vehicle environmental interactions. Several other small-scale basic and applied research programs with Russia are currently being sponsored by BMDO.

7.3.11 Central and East Europe

BMDO is exploring opportunities for joint projects on technological research and cooperation with several countries in Central and East Europe. Dialogue, and in some cases, specific small projects, have been started with the Czech Republic and Poland.

7.4 Summary

Allied participation in the CNAD MDAHG, MEADS, national studies, and other areas of TMD cooperation reflect the growing concern within the international community regarding the proliferation of ballistic missiles and WMD, and a willingness to address real and perceived limitations to national defense planning and capabilities. Continued allied participation and cooperation in the U.S. BMD program provides the framework for developing and deploying affordable, effective and interoperable TMD systems.

Chapter 8

Ballistic Missile Defense Countermeasures

Chapter 8
Ballistic Missile Defense Countermeasures

8.1 Introduction

Changes in adversary countries' current operational employment of ballistic missiles in reaction to United States ballistic missile defense have been a critical consideration in developing ballistic missile defense strategy since the early days of the Strategic Defense Initiative (SDI) program. Public Law 99-145, Section 222 (dated November 8, 1985) states "A strategic defense system development, test, and evaluation conducted on the Strategic Defense Initiative Program may not be deployed in whole or in part unless the President determines and certifies to Congress in writing that - (A) the system is survivable (that is, the system is able to maintain a sufficient degree of effectiveness to fulfill its mission, even in the face of determined attacks against it)" and "(B) the system is cost effective at the margin to the extent that the system is able to maintain its effectiveness against the offense at less cost than it would take to develop offensive countermeasures and proliferate ballistic missiles necessary to overcome it;...", To address these concerns, the BMD program has within its organizational structure a Countermeasure Integration Program (CMIP). The CMIP mission is to provide a systems engineering approach to help identify risk associated with the reactive threat and to help BMD system designers develop options for managing risk associated with potential threat excursions outside their design space. This process is known as the Threat Risk Assessment Process (TRAP).

TRAP is a cooperative systems engineering process conducted jointly by the "Blue" system developers and the BMDO "Red" team of reactive threat experts. The TRAP is a rigorous and detailed process to identify potential design susceptibilities and then examine if those susceptibilities could be easily exploited by Rest-of-World (ROW) countries. The process then attempts to evaluate the likelihood of the exploitation concepts and thus assess the threat risk to the system being examined. The BMDO leadership can then develop risk management options which might range from accepting the risk to changing the system design.

The BMDO scope of missions has changed to include TMD, NMD, and Cruise Missile Defense (CMD). The CMIP focus has changed along with this expansion of mission from characterizing countermeasures to being prepared to assess the threat risk associated with any of these programs.

8.2 Theater Missile Defense

Since 1991, the BMD countermeasures program has concentrated on characterizing and analyzing the potential countermeasures available to ROW countries and the effect of these countermeasures on TMD systems. BMDO completed four extensive analyses (Red-Blue Exchanges) of the effect of potential ROW countermeasures on TMD systems. These Red-Blue Exchanges investigated and analyzed potential countermeasures. The Red-Blue Exchanges analyzed the impact of some countermeasures upon the effectiveness of the BM/C^3 architecture, THAAD, PATRIOT PAC-3, MEADS, AEGIS SM-2 Block IVA (both upper- and lower-tier), and Arrow. The CMIP is currently refining the TRA process to meet the needs of the TMD systems engineer.

The CMIP developed and continues to utilize an innovative method of assessing the difficulty for a ROW-like country to develp, build, and deploy countermeasures. This project, known as the Countermeasures Hands On Program (CHOP), uses a small team of junior engineers to design, fabricate, assemble, and ground or flight test BMD countermeasures in a simulated ROW environment. This information is utilized in the TRA process to resolve issues which are derived from the process. Answering the "difficulty" question is extremely important in trying to determine the "likelihood" of a reactive threat concept and thus assessing the risk to a system.

In summary, BMDO has diligently investigated the technical feasibility and difficulty of ROW countermeasures and their effect upon TMD system performance. This information is shared with the TMD system developers and intelligence community to prevent surprises and prepare for possible indicators of ROW reactive threat development. This countermeasures work supports the TMD systems engineering process and the threat risk management strategy.

8.3 National Missile Defense

BMDO completed a Red-Blue Exchange on the NMD First Site System in FY 1994. The Red Team analyzed the susceptibility of the NMD system and devised technologically feasible countermeasures from potential adversaries. As with the TMD system, the CMIP is currently refining the TRA process to meet the needs of the NMD systems engineer. Specifically, the TRA process will be utilized to help the NMD systems engineer define the "design-to-threat" that should be used in the design process.

The Countermeasures Program is currently working on a flight experiment, code named "Red Crow," which will help to characterize and evaluate potential NMD countermeasures. The test is currently scheduled to be conducted in FY 1998.

8.4 Cruise Missile Defense

Cruise Missile Defense is in its infancy in BMDO and therefore the CMIP has not conducted any past Red/Blue exercises or analysis in this area. However, the TRA process is very adaptive to help assess the cruise missile threat, particularly when the system description becomes clearer. The Air Force views CMD as part of its Air Defense Mission, and will work closely with BMDO to develop a CMD capability.

Appendix A

Annual Report To Congress On Ballistic Missile Defense

Annual Report To Congress On Ballistic Missile Defense

Reporting requirements for the Annual Report to Congress on Ballistic Missile Defense as specified by section 224 of the National Defense Authorization Act for Fiscal Years 1990 and 1991, as amended by section 240 of the National Defense Authorization Act for Fiscal Year 1994, as amended by section 234 of the National Defense Authorization Act for Fiscal Year 1996, and as amended by Section 244 of the National Missile Defense Authorization Act for Fiscal Year 1997.

(1) A statement of the basic strategy for research and development being pursued by the Department under the Ballistic Missile Defense program, including the relative priority being given, respectively, to the development of near-term deployment options and research of longer-term technological approaches.

(2) A detailed description of each program or project which is included in the Ballistic Missile Defense program or which otherwise relates to defense against strategic ballistic missiles, including a technical evaluation of each such program or project and an assessment as to when each can be brought to full-scale engineering development (Engineering Manufacturing Development, assuming funding as requested or programmed).

(3) The status of consultations with other member nations of the North Atlantic Treaty Organization, Japan, and other appropriate allies concerning research being conducted in the Ballistic Missile Defense program.

(4) A statement of the compliance of the planned BMD development and testing programs with existing arms control agreements, including the 1972 Anti-Ballistic Missile Treaty.

(5) A review of possible countermeasures to specific BMD programs, an estimate of the time and cost required to develop each such countermeasure, and an evaluation of the adequacy of the BMD programs described in the report to respond to such countermeasures.

(6) Details regarding funding of programs and projects for the Ballistic Missile Defense program (including the amounts authorized, appropriated, and made available for obligation after undistributed reductions or other offsetting reductions were carried out), as follows:

- (A) The level of requested and appropriated funding provided for the current fiscal year for each program and project in the Ballistic Missile Defense program budgetary presentation materials provided to Congress.
- (B) The aggregate amount of funding provided for previous fiscal years (including the current fiscal year) for each program and project.
- (C) The amount requested to be appropriated for each such program and project for the next fiscal year.
- (D) The amount programmed to be requested for each such program and project for the following fiscal year.

(E) The amount required to reach the next significant milestone for each demonstration program and each major technology program.

(7) Details on what Ballistic Missile Defense program technologies can be developed or deployed within the next 5 to 10 years to defend against significant military threats and help accomplish critical military missions. The missions to be considered include the following:

(A) Defending elements of the Armed Forces abroad and United States allies against tactical ballistic missiles, particularly new and highly accurate shorter-range ballistic missiles of Russia armed with conventional, chemical, or nuclear warheads.

(B) Defending against an accidental launch of strategic ballistic missiles against the United States.

(C) Any other significant near-term military mission that the application of BMD technologies might help to accomplish.

Appendix B

Current Program, Projects, And Activities - Narrative Description And Status

PROJECT NUMBER: 1155
PROJECT TITLE: Phenomenology
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0603173C RDT&E	18,309	26,740	26,205

PROJECT DESCRIPTION:

To prepare for critical future missile defense needs, advanced technology programs will conduct a balanced program of high leverage technologies that yield improved capabilities across a selected range of boost, midcourse, and terminal phase missile defense interceptors, advanced target sensors, and innovative science. The objectives of these investments are subsystems with improved performance or reduced costs for acquisition programs, and technical solution options to mitigate advanced and unpredicted threats.

This program provides the United States with the data and predictive tools to generate high confidence target signatures for Ballistic Missile Defenses (BMD). This is a critical adjunct to the evaluation of BMD system performance across the full spectrum of threats and engagement scenarios. This program provides data collection sensors and instruments for use on live-fire missions and provides analysis of the resulting test data. This program provides predictive models of target signatures in both Radar and Infrared spectrums. This program evaluates and develops algorithms for the critical functions of discrimination, target handover, and aim point selection. This program provides for data storage and retrieval of all BMDO-sponsored tests per statutory requirements.

Space-based Phenomenology Program Database Development is the work to expand the database for background data through the analysis of Midcourse Space Experiment (MSX) data. This effort will include analysis of the background data for its impact on current and future elements of the NMD program, especially the Space Based Infrared System (SBIRS).

Data Collection is the program to provide effective and robust threat signature collection for ballistic missile defense programs. This program analyzes existing and emerging requirements for signature data collection capabilities. This program provides mission planning for all BMDO signature collection activities. These activities include providing for the maximum use of existing high altitude data collection aircraft to collect ballistic threat signatures in all phases of flight. Signature data dissemination and modeling tie-in with higher level simulations will be developed. Evaluation, development, and employment of several types of potential data collection sensors will be conducted per the direction of the Office of the Secretary of Defense (OSD). This program develops responsive access to stored signature data. This program provides exploitation of new signatures provided by emerging sensing techniques.

PROJECT NUMBER: 1155
PROJECT TITLE: Phenomenology
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0603872C RDT&E	31,338	37,835	38,622

PROJECT DESCRIPTION:
This project provides the United States with the data and predictive tools to generate high confidence target signatures for Ballistic Missile Defenses (BMD). This is a critical adjunct to the evaluation of BMD system performance across the full spectrum of threats and engagement scenarios. This program provides data collection sensors and instruments for use on live-fire missions and analysis of the resulting test data. This program provides predictive models of target signatures in both Radar and Infrared spectrums. This program evaluates and develops algorithms for the critical functions of discrimination, target handover, and aim point selection. This program provides for data storage and retrieval of all Ballistic Missile Defense Organization (BMDO)-sponsored tests per statutory requirements.

Data Centers and Management. Storage, archival and retrieval of signature related data is provided by the BMDO-funded Missile Defense Data Center (MDDC) and Advanced Missile Signature Center (AMSC). The MDDC is the primary repository of THAAD data. Both the MDDC and AMSC meet the statutory requirements for program data archiving.

Data Collection Platforms. This project provides core operating costs for Airborne Surveillance Testbed (AST) target signature collection sensor and platform. Mission costs for AST are provided by using acquisition programs. This project provided FY96 termination costs for the COBRA EYE sensor. This project monitors other BMDO signature data collection programs to ensure complete coverage and avoid duplication.

Analysis, Algorithms, and Modeling. This project performs analysis of radar and optical data on ballistic missile threat signatures and intercept events for the THAAD Radar, THAAD interceptor, and Navy TMD programs. This project develops and evaluates discrimination and kill assessment algorithms for THAAD Radar. This project develops signature models and modeling tools applicable to TMD threat profiles and flight regimes leveraging off investments made in TMD modeling and modeling tools.

For analysis this project provides accurate, objective, and timely flight data analysis in support of target signature phenomenology characterization and sensor algorithm development and evaluation. This includes TMD optical sensor data from THAAD, project 1170, project 3270, and others. This project provides post-flight characterizations of expected and unexpected target features. Under the guidance of the Target Signatures Working Group (TSWG) develop target models and provide high fidelity signature sets of THAAD Dem/Val and User Operational Evaluation System (UOES) targets. Evaluate THAAD software aim point selection, discrimination, and handover algorithms against Dem/Val targets and UOES threats. Provide analysis and recommendations for TMD aim point selection, discrimination, and sensor handover.

For THAAD Radar algorithms this project develops and analyzes algorithms that have the highest payoff potential for the critical functions of detection, tracking, bulk classification, typing, discrimination, target object map generation, aim point selection, and kill assessment. Maintenance and upgrades to the simulation facilities required to develop and evaluate these algorithms against real and simulated data is provided for. The Lexington Discrimination System (LDS) will be used to merge radar and optical data analysis on a real-time basis for algorithm development and assessment. Specific tasks include: (1) Use LDS to support development and evaluation of objective system algorithms to be installed on the THAAD Radar, THAAD Interceptor, and Navy TMD programs; (2) Use signature data to identify robust discriminants using field measurements; (3) Develop and deliver individual radar discrimination algorithms based on identified discriminants; (4) Develop, deliver, and exercise on the LDS, algorithms which utilize radar and optical data to facilitate seeker Target Object Map and aim point selection for THAAD and other TMD systems; and (5) Complete the LDS real-time multiple-sensor, multiple target handling capability and test TMD algorithms/architectures using this capability.

For modeling this project provides high confidence, target and background scene predictions for sensors and BMD systems. These generated scenes are the foundation for high confidence simulations of engagements that cannot or will not be flight tested. The high-fidelity, physics-based models, predicted composite scenes, and associated analytic output developed in this task are evaluated against measured data to ensure confidence in simulation results and provide a reliable route to systems verification and validation. To facilitate this objective, this task also provides crucial data-driven software tools for exploiting measured data and integrating measurements with simulations in support of technology development, test and evaluation, and acquisition efforts.

This project also provides for participation in international technical exchange programs in the areas of optical and radar discrimination, reentry, and background and plume phenomenology include: U.S./U.K. Scientific Cooperation Research Exchange (SCORE); use of the U.K. MESAR Radar; NATO Extended Air Defense (EAD)/TMD Ad Hoc Working Group - Plume Phenomenology Expert Group (U.S., U.K., France, Canada); U.S./French Bilateral Group - Plumes, Backgrounds, and Reentry Signatures; U.S./Israeli TBM Signature and Phenomenology Research; and the U.S./German Phenomenology Research committee.

PROJECT NUMBER: 1161
PROJECT TITLE: Advanced Sensor Technology
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	**FY98**	**FY99**
0603173C RDT&E	32,797	24,527	22,743

PROJECT DESCRIPTION:

To prepare for critical future active defense needs, advanced technology programs will conduct a balanced program of high leverage technologies that yield improved capabilities across a selected range of boost, midcourse, and terminal phase missile defense interceptors, and advanced target sensors, as well as advances in innovative science. The objectives of these investments are sub-

systems with improved performance, reduced costs for acquisition programs, and technical solution options to counter advanced and unpredicted threats.

The Advanced Sensor Technology Program (ASTP) is BMDO's principal advanced sensor program. ASTP is a joint Army, Navy, Air Force technology development and demonstration program, managed by BMDO. The purpose of ASTP is to provide the sensor technology needed to detect, track, and discriminate advanced (post-2000) BMD threats. The technologies for ASTP were chosen through a technology requirements analysis driven by BMD missions, threats, system requirements, and schedules. Care was taken to avoid duplication with other programs both within and external to BMDO. Starting in FY96, ASTP realigned interceptor-related technology efforts under Project 1270 to correspond with their discriminating interceptor technology focus.

The three Services and BMDO are developing technologies in their Project Reliance areas of expertise. The Air Force is developing passive sensor technology, the Army - ladar technology, and the Navy - radar technology. These technologies will be infused from ASTP into BMDO core programs as they mature.

In addition to development of critical component technologies, the three Services, in conjunction with BMDO, will combine these critical components in an integrated sensor for demonstrating data fusion by FY01. Data from the passive, ladar and radar sensors will be combined (fused) in a BMDO-developed fusion processor for tracking and discrimination.

Real-time data fusion is a central focus of ASTP. It is identified by the technical requirements analysis as the best solution to the difficult signal processing problem. High-speed data fusion algorithms are under development by BMDO for this critical need.

Laboratory and field demonstrations of ASTP technologies are being conducted throughout the program, starting with advanced focal plane imaging demonstrations conducted at White Sands Missile Range (WSMR) NM in FY95. Larger experiments will permit fusion of radar, infrared, and ladar data beginning in FY96 and FY97, when scaled rocket flights will provide initial collocated multi-sensor data for benchmarking of tracking algorithms. The first integrated demonstration of ASTP subsystems will be at the Pacific Missile Range Facility (PMRF), Kauai, Hawaii ground test facility, where radar and optical sensors will detect and track missiles beginning in FY00. Successful performance of the radar-to-system interface and tracking algorithms will signal the transition to the airborne demonstration phase, which begins FY01.

BMDO has selected a Government system integration team led by Naval Research Laboratory/ Navy Air Systems Team (NRL/NAST). This System Integrator (SI) will oversee the installation of ASTP equipment at the test ranges, and will integrate the sensors and other equipment into the P-3 aircraft. Additionally, the SI will operate the ASTP equipment during the airborne demonstrations.

The technologies under development in ASTP are:

Multiple Quantum Well (MQW) Focal Plane Arrays (FPA). MQW FPAs have made rapid progress in the past three years, and are now available in 256x256 format with quantum efficiency

approaching 30%. This technology is important due to its potential for high sensitivity, low noise, high uniformity imaging and low production cost.

Simultaneous Multicolor FPAs. FPAs capable of simultaneously measuring two or more Infrared (IR) wavebands will simplify sensor design for both surveillance and interceptor seekers. The result will be highly sensitive, discriminating sensors which are more reliable, lighter, and less costly than currently available

Smart FPAs. Preprocessing sensor data on or near the FPA greatly improves processing throughout. This provides the overall processing speed needed for real-time data fusion for accomplishing multiple target tracking, discrimination, and tracking low-observable targets in clutter.

Imaging Ladar. Miniature Laser Radar (LADAR) integrated with passive sensors will allow precise tracking and discrimination of BMD targets. Ladar capable of range-doppler and 3-dimensional imaging are under development. Eye safe ladar is being developed for airborne applications. The ladar technology is also consistent with interceptor technology requirements.

Radar. Reliable booster detection and tracking through cloud-cover requires radar observations. ASTP is leveraging an existing NRL airborne UHF surveillance radar technology program based on the APS-145 to demonstrate TBM detection and early ascent phase tracking.

Transmit/Receive (T/R) Modules. The radar T/R Module program will develop and demonstrate technologies required to increase output power and power added efficiency, and reduce the noise figure of 10 Ghz (X-band) T/R modules for use in radars.

Real Time Data Fusion Algorithms. Techniques for combining (fusing) data for tracking multiple targets, discrimination, and sensor optimization are under development. The algorithms are critically needed as principal elements of the fusion processor. They are the central focus of the ASTP data fusion effort.

Russian American Cooperative Programs:

- The RAMOS program is a cooperative effort with Russian scientists and engineers to exchange IR data acquired through remote sensing systems and to develop plans for future cooperative space experiments. This program investigates options to leverage off existing funded experiments to foster a closer working relationship at the technology level between both nations.
- The AGRE is an upper atmospheric joint research project with Russian scientist, using Russian launch vehicles and U.S./Russian onboard sensor packages, Russian ground optical/radar sites, and U.S. MSX satellite to monitor experiments and collect data.

Down Under Early Warning Experiment (DUNDEE). DUNDEE is a cooperative advanced BMD sensor and BM/C^3 technology research demonstration with the Australian Defense Science Technology Organization (DSTO). Objectives are to perform research, demonstration, and post mis-

sion data reduction using the Australian Jindalee Over-the-Horizon Radar to detect TBM and Cruise Missile targets. Specific objectives include: wide area, timely launch detection; target identification using plume doppler signature; and trajectory association with satellite detection reports.

PROJECT NUMBER: 1161
PROJECT TITLE: Advanced Sensor Technology
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0603872C RDT&E	3,334	3,364	3,208

PROJECT DESCRIPTION:
The goal of this program is to develop and demonstrate survivability technologies to ensure that Theater Ballistic Missile Defense (TMD) systems can perform their mission in all required environments. Ballistic missile defenses must be able to operate in nuclear environments and against countermeasure threats. The requirements for the Survivability program are: define, develop and demonstrate Survivability Enhancement Options (SEO) for TMD systems; develop and transfer SEO technology base to research and development centers and laboratories; provide risk reductions to support THAAD Radar Milestone II.

This program develops and demonstrates survivability technologies to ensure that TMD elements can perform their mission in all expected hostile threats. Approaches include: studies/analyses; defense suppression threat mitigation technologies development; developing enhanced shelters applying Camouflage, Concealment and Deception (CCD), SEO development; Electromagnetic Environmental Effects (E3) engineering support, survivability/operability demonstrations, development of issue resolution approaches; development of Anti-Radiation Missile (ARM) Countermeasure Evaluator (ACE); and hardened technology integration. ACE combines the desirable effects of low-cost digital simulations and hardware testing of actual ARM hardware in open- and closed-loop simulations. ACE will be used to develop initial ARM Electronic Countercountermeasure (ECCM) techniques for THAAD/GBR and PAC-3. The multispectral signature of the deployed THAAD Radar system requires application of extensive CCD technologies which have been developed by the Army Labs. Technologies will be available for incorporation into core missile defense systems at Engineering Manufacturing Development (EMD), will provide near-term improvements to existing systems, and will provide necessary risk reduction evidence to support THAAD Radar, and Medium Extended Air Defense System (MEADS) system milestone decisions.

This program has developed tools to evaluate THAAD Radar performance under defense suppression threats and in hostile environments. These evaluations support the THAAD Radar Milestone II decisions. The ACE operational capability was demonstrated. Countermeasures for precision guided missiles and cruise missiles continued to be developed. CCD techniques applied to the THAAD Radar were evaluated for effectiveness in battlefield conditions. Requirements for the THAAD Radar to be protected against electromagnetic environmental effects were reviewed and design guidelines were identified.

PROJECT NUMBER: 1170
PROJECT TITLE: TMD Risk Reduction
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0603872C RDT&E	23,184	35,267	25,045

PROJECT DESCRIPTION:
This project is the primary BMDO risk mitigation program addressing TMD target/threat signature and the sensor-to-system interface issues for all TMD systems. How potential targets appear to radar and infrared seekers is an important issue which allows TMD acquisition programs to limit costs by concentrating designs on narrow bands of key threat signature characteristics. This project consists of five elements: TMD Critical Measurements Program (TCMP) which builds, flies, observes, and analyzes targets with signature characteristics similar to those anticipated on foreign threats; the Target Signature Measurements Program which observes and directs the analysis of signatures from BMDO test targets (STORM, Hera, etc.) to obtain target signature insights, and which exploits other similar threat signature opportunities; the TMD Seeker Test/ Measurements Program which uses an experimental seeker test bed to evaluate emerging missile seeker technologies and to support resolution of unexpected critical problems that emerge during their engineering and testing phases; Kill Assessment Program which investigates the signatures and results of a target intercept; and the Sapphire Statistical Characterization and Risk Reduction (SSCARR) program which determines window/dome reliability and fabrication techniques. In all cases, the target signature data and the analyses address specific questions relating to how a radar first identifies a missile (discrimination), how the radar passes the missile location to a seeker (sensor to seeker handover), how the seeker determines the best place to hit the target (aim point selection), and how the defender can tell if a missile is destroyed (kill assessment). The core sensor costs used in this project to collect target signature data will be provided under projects 1155 and 3360. This project funds the specific sensor tasks for each mission.

TMD Critical Measurements Program. This program supports the risk mitigation efforts in TMD signatures. TCMP is a flight test program where threat representative targets are flown at the Kwajalein Missile Range (KMR) or other facilities to observe typical threat-like objects in flight with a sophisticated suite of sensors. These sensors give both target data and representative signature data as seen by TMD system sensors. The TCMP program performs the analysis on the data obtained in these flights. In all cases, the target and threat data and the analysis address the specific areas of discrimination, target object map handover and aim point selection. The hardware, flight instrumentation and data analysis of the TCMP flights are all included in the TCMP budget. TCMP 2 will consist of three medium range flights, in the fourth quarter of FY96 and two in the second quarter FY97.

Kill Assessment. This program is developing the technical basis for the TMD architecture battle management decision kill assessment capability. This capability will enable the battle manager to respond nearly real time following a target intercept engagement to cease-fire, to order a second shot, or to cue the lower tier for appropriate action. This kill assessment capability will also help measure defense system effectiveness and identify threat warhead type. In support of this shoot-look-shoot doctrine, the program is conducting a series of specialized sensor data collections of TMD interceptor tests, follow-on data analysis, and algorithm development. The most challenging

aspect is gathering enough pertinent data from various types of intercept scenes to identify and evaluate those observable characteristics serving this decision process. Since opportunities to observe actual TMD missile intercepts are rare, this program will emphasize ground test measurements and construction of analytical models and tools for developing and validating algorithms for the TMD acquisition program.

TMD Seeker Test/Measurements: This program provides for the application, integration, and testing of the latest available seeker technologies into on-going TMD seeker designs. The program is divided into two parts; the first supports the Seeker Experimental System (SES) which is used to evaluate missile seeker performance functions and the second is a seeker window sapphire material characterization effort designed to provide a critical database for designers to evaluate seeker window performance in the high temperature, low altitude flight regime. The SES provides BMDO with independent evaluation of emerging seeker technologies in a realistic system context, allowing for risk assessment prior to acquisition commitment. In supporting the solution of technical problems arising in seeker acquisition programs, the SES can address a wide range of design and implementation issues such as hardware/software integration and evaluation of seeker functional algorithms. The sapphire material test activities serve as risk mitigation for Theater High Altitude Area Defense (THAAD), Navy Standard Block IVA Missile and the Arrow Programs for improved survivability confidence of the seeker window.

Target Signature Measurements. This program funds the per mission costs to acquire data using sophisticated sensor platforms (Airborne Surveillance Testbed, HALO, Sealite Beam Director, etc.) on BMDO interceptor target flights (LANCE, STORM, Hera, etc.). This program also provides the tasking through the Target Signatures Working Group (TSWG) and the funding for each mission to the sensor platforms for each flight. The data collected is utilized by the acquisition programs, the TSWG, and the Targets Program to establish target in-flight signature characteristics for use in hardware development and interceptor algorithm assessment.

SSCARR is a joint effort involving the THAAD, Navy SM Block IVA, and Arrow programs. Due to its mechanical strength, high thermal conductivity, and high transparency in the mid-wave infrared, sapphire has become the material of choice for TMD seeker windows and domes. SSCARR employs statistical procedures to determine window/dome reliability for the participating programs. This probability of failure data will allow designers and battle planners to more fully exploit the interceptors' available battlespace. In addition, diagnostic techniques are being used in an attempt to demonstrate correlation's between sapphire surface and volume features and "weak" sapphire, thus providing a sapphire screening technique. Potential follow-on activities to SSCARR include a computational fluid dynamics validation effort with emphasis on problems relating to predicting jet interaction effects, an assessment of advanced seeker window technology to remove blur where extreme accuracy in angle-rate measures are required, and an investigation of the utility of reactive materials on hit-to-kill interceptors.

PROJECT NUMBER: 1262
PROJECT TITLE: Corps SAM/MEADS Concepts
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0603869C RDT&E	56,232	47,956	9,509

PROJECT DESCRIPTION:
The Corps SAM/Medium Extended Air Defense System (MEADS) is an advanced air and missile defense system. Corps SAM/MEADS is designed to fill a critical void providing highly mobile defense of maneuver forces from ballistic and cruise missiles and Unmanned Aerial Vehicles (UAVs). In May 1996 the Memorandum of Understanding (MOU) among the U.S., Germany, and Italy was signed. Subsequently, in June 1996, the Charter for the North Atlantic Treaty Organization (NATO) MEADS Design and Development, Production, and Logistics Management Organization (NAMEADSMO) was approved. In accordance with these directives, the NATO MEADS Management Agency (NAMEADSMA) is responsible for the accomplishment of the Project Definition/Validation Phase (PD/V). The objective of the PD/V Phase is (1) to define and validate through engineering analyses, simulations and demonstrations a MEADS which is compliant with the commonly agreed requirements of the Participants, while taking maximum advantage of the technology existing in the countries of the Participants and (2) to define a balanced cooperative Program to develop, produce in single source and support MEADS which has acceptable technical and financial risks for the Participants. The Corps SAM/MEADS National Product Office has also been established and will be responsible for planning, budgeting, and coordinating all U.S. national efforts in support of the MEADS program as well as executing national specific tasks related to satisfying the Corps SAM requirements.

The Corps SAM/MEADS mission and consequently its design is a function of the assets that Corps SAM/MEADS must protect, the threat against these assets, and the depth and nature of the battlefield. Corps SAM/MEADS will be designed to deal with shorter range Tactical Ballistic Missiles (TBMs), cruise missiles, UAVs, and other air breathing threats. It will be required to protect critical maneuver force assets throughout all phases of tactical operations and it will be operating in the division area of the battlefield outside the umbrella of an upper tier system. Corps SAM/MEADS will be designed to provide: (1) defense against multiple and simultaneous attacks by Short Range Ballistic Missiles (SRBMs), low cross-section cruise missiles, and other air-breathing threats to the force; (2) immediate deployment for early entry operations with as few as six C-141 sorties; (3) mobility to move rapidly and protect maneuver force assets during offensive operations; (4) a distributed architecture and modular components to increase survivability and flexibility of employment in a number of operational configurations; and (5) a significant increase in firepower while greatly reducing manpower and logistics requirements. Given these characteristics, Corps SAM/MEADS will be able to rapidly respond to a variety of crisis situations and satisfy the needs of the joint operational and tactical commanders.

PROJECT NUMBER: 1266
PROJECT TITLE: Navy Theater Wide MD (Upper Tier)
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0603868C RDT&E	304,171	194,898	192,073

PROJECT DESCRIPTION:

The Navy Theater Wide (NTW) Ballistic Missile Defense (BMD) program builds upon the Navy Area Theater Missile Defense (TMD) program and the national investment in AEGIS ships, weapons systems, and missiles. Two classes of ships are deployed with the AEGIS combat system: the Ticonderoga Class cruisers and the Arleigh Burke Class destroyers. Navy Theater Wide BMD will take advantage key naval forces attributes including overseas presence, mobility, flexibility, and sustainability to provide protection of a theater of operations.

The Navy Theater Wide BMD program will provide an exoatmospheric naval regional defense capability to counter the TBM threat. In accordance with the BMD Program Review in early 1996, the Navy Theater Wide program is conducting the following activities: an AEGIS LEAP system level intercept demonstration, Kinetic Warhead (KW) technology assessments and concept definition studies, and system engineering efforts to identify key technical risk reduction activities including discrimination and KW lethality. Since the FY97 President's Budget request, the Department has provided additional funds for FY98-01 to increase testing and conduct more in-depth risk reduction. Ongoing advanced technology studies provide the anticipated objective system improvements required to meet the evolving threat.

This project is assigned to the Budget Activity and Program Element codes as identified in this descriptive summary in accordance with existing Department of Defense policy.

PROJECT NUMBER: 1270
PROJECT TITLE: Advanced Interceptor Materials and Systems Technology
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0603173C RDT&E	68,409	31,492	29,412

PROJECT DESCRIPIION:

To prepare for critical future defense needs, advanced technology programs will invest in a balanced program of high leverage technologies that yield improved capabilities at affordable cost with lower technical and schedule risks for boost phase and terminal missile defense interceptors, advanced target sensors and future space surveillance and defense systems. The objectives of these investments are component and systems technologies with improved performance and reduced costs for acquisition programs, and technical solution options to mitigate advanced and unpredicted threats.

The Advanced Interceptor Materials and Systems Technology (AIMST) program develops and demonstrates the following for interceptor and space surveillance systems: advanced interceptor sensor processing and power components; multifunctional material and structures; low cost interceptor composite manufacturing processes; and low cost flight test demonstrations. These technologies are critical to the deployment of effective, affordable TMD and NMD systems.

The near term AIMST projects are planned and executed through direct interchange with System Program Offices (SPOs) and prime contractors responsible for fielding current NMD Technology

Readiness and TMD systems hardware. The execution of this comprehensive technology program, however, is slowed by funding limitations. This impedes efforts on near term technologies that will increase interceptor and sensor performance while lowering deployment costs.

The AIMST program consists of six major task programs: Discriminator Interceptor Technology, Materials and Structures, Power Technology, Endoatmospheric Flight Experiment (EFEX), the Space Technology Research Vehicle (STRV), and the Atmospheric Interceptor Technology (AIT) programs.

Discriminator Interceptor Technology Program: The Discriminator Interceptor Technology Program (DITP) develops subsystems necessary to achieve long range threat acquisition and tracking, accurate homing guidance, robust discrimination, and aim point selection for autonomous hit-to-kill interceptors. Passive infrared sensors, and laser radars (LADARs) are being designed, fabricated, and tested. Emphasis is placed on increasing active sensor output power, miniaturization, and ladar waveform generation to support onboard imaging. The primary goal of the DITP program is interceptor flight demonstrations of the integrated sensor suite, with its data fusion processor and associated discrimination/data fusion algorithms, to demonstrate the performance and readiness of the advanced subsystems to support future form-fit-function upgrades to NMD and TMD interceptors.

The Materials and Structures Program: The materials and structures program develops and demonstrates: advanced, low cost to manufacture, multifunctional, composite structural components; adaptive and passive vibration isolation and suppression systems; optical materials and baffle specialty components; and low temperature superconductor LWIR sensor electronics. This program also evaluates new high temperature, composite materials for use in manufacturing propulsion components such as ceramic hot gas lines, combustion chambers, nozzles, and exit cones. Many projects executed under the Materials and Structures Task, which includes the EFEX and STRV programs, rely on cofunding from other agencies (AF, USA, DARPA, NASA) or international partners (U.K., Japan). In some cases this cooperative funding represents a substantial portion of the total project cost. Reductions in current or future cooperative funding will adversely impact planned goals and schedules.

Power Technology Program: The power program develops concentrator solar arrays (SCARLET); electric generators, thermal management components, and power conditioning for GBR; and batteries for TMD and NMD interceptors. The technologies will improve system performance in terms of reducing recurring costs, lowering mass and increasing efficiency.

Endoatmospheric Flight Experiment (EFEX) Program: This multiflight test program will use existing sounding rockets to provide the hypersonic flight environment to validate advanced interceptor technologies. Lightweight, ultrastiff, high temperature, multifunctional structures, optical and structural thermal control concepts, super-tough optical windows and erosion resistant coatings, emergent processing and guidance schemes, miniature inertial systems, advanced shroud concepts, propulsion systems, and dual mode seekers and aperture will be tested. The flight test results will be correlated with aerothermal-mechanical test results from ground-based hypersonic and shock tube facilities in the 3 to 4 km/sec velocity and 20 km to 45 km altitude range. Subsequent tests will emphasize high-g maneuverable flight profiles.

Space Technology Research Vehicle Program (STRV-1c/d, STRV-2 and STRV-3): The STRV-2 Experiment Module will consist of an advanced composite structure supporting the following 6 primary payloads: (1) a U.K. provided Mid-Wavelength Infrared (MWIR) experiment; (2) the Vibration Isolation Suppression System (VISS); (3) the Space Active Modular Materials Experiment System (SAMMES); (4) the Electronic Test Bed (ETB); (5) the Laser Communications Experiment (Lasercom); and (6) the Micro-Meteoroid And Debris (MM&D) experiment. The low outgassing, high stiffness and high strength composite structure is part of the overall experiment providing critical validation for incorporation of this technology in future systems. Multiple sensors will be used to measure local contamination from all sources, including the composites used in structures. The primary payloads form an overall integrated payload. MWIR background/clutter data will be obtained using filters specified by the Space and Missile Tracking System (SMTS) SPO. Data on the space environment at SMTS mission altitudes and its effects on materials, components and systems will be obtained. A one year mission is planned. Efforts have been initiated to conduct follow-on cooperative space experiments with the U.K. using micro satellites based on the recent U.S./U.K. STRV 1a/b program. These U.K.-provided micro satellites (STRV 1c/d) have a nominal launch planned for FY99. The experiments to be flown on STRV 1c/d include a Quantum Well Infrared Photometer (QWIP) sensor and a multifunctional composite structure. The Space Technology Research Vehicle-3 (STRV-3) will be a U.S.-led multiagency, multinational (U.K., U.S. allies) cooperative space experiment effort. The program is in the preliminary discussion stage.

Atmospheric Interceptor Technology (AIT) Program: The AIT program will develop, integrate and demonstrate the critical technologies for performing hypersonic hit-to-kill intercepts of TBMs within the atmosphere. The demonstrations will validate the solution to critical KKV technologies and will provide: (1) new capabilities with reduced costs/risks compared to current interceptor weapons systems, and enhancements to other interceptors under development; (2) reduction of technical risks and costs in support of acquisition programs through direct technology insertions; and (3) technical solutions to provide theater defense interceptor capabilities for contingencies not currently addressed by the TMD system programs. The program uses existing contracts and technologies currently under development to reduce schedule and cost, and will be planned and conducted with BMDO, Air Force, Navy, and Army elements to make maximum use of existing Service infrastructures. The AIT project will participate in the UAV/BPI Studies (PMA 1294) and the Navy Theater Wide requirements studies.

PROJECT NUMBER: 1294
PROJECT TITLE: UAV Boost Phase Intercept
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0603870C RDT&E	23,276	12,885	0
0603872C RDT&E	930	0	0

PROJECT DESCRIPTION:

The Unmanned Aerial Vehicle (UAV)-Based Boost Phase Intercept (BPI) project covers two tasks; Task 1: Cooperative UAV-Based BPI project with Israel, and Task 2: Development of a U.S. UAV-Based BPI Concept. Task 1 is a cooperative U.S./Government of Israel (GOI) BPI program which involves future development and refinement (risk mitigation) of the Israeli Boost

Phase Intercept System (IBIS) concept which is planned to destroy tactical ballistic missiles in the boost phase of flight, before engine cutoff, preferably while in enemy territory. This project is based on the use of UAVs armed with onboard interceptors to provide the means of destroying enemy missiles in their boosting phase of flight. The first task of this two-part project will provide risk mitigation in the development of the GOI's UAV BPI. Task 2 of this effort develops a U.S. UAV-based BPI system concept. It will develop the system requirements, to include: kinetic energy interceptors, UAVs, search and track sensors, Battle Management, Command, Control, Communications, Computers and Intelligence (BM/C^4I), and the concept of operations (CONOPS) based on readily available U.S. technologies.

PROJECT NUMBER: 1360
PROJECT TITLE: Directed Energy Programs
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0603173C RDT&E	95,930	28,877	28,539

PROJECT DESCRIPTION:
BMDO's charter is to provide for defense against current and future missile threats. An effective missile defense against a wide variety of current and near term projected threats will require boost phase intercept capability. The Space Based Laser (SBL) program was created to provide the nation with a highly effective, continuous, global boost phase intercept option for both theater and national missile defense. While BMDO is pursuing numerous terminal and midcourse intercept concepts, this program element, project number 1360, contains DoD's only boost phase intercept program that can provide national missile defense and operate in all theaters, regardless of size, geometry, or weather conditions. This system also provides many ancillary capabilities, including air defense, global surveillance and target detection and designation for other systems.

Unique features of an SBL missile defense system include global, 24 hour boost phase intercept capability and defense against surprise first strikes. SBLs can destroy missiles whose range is greater than 75 miles, providing a robust first layer for both theater and national missile defenses-in-depth. SBLs do not require prior knowledge of enemy launch site locations. The footprint of one SBL can cover approximately 10% of the earth. Twenty SBLs could provide overlapping full-time coverage of missile threats from theaters anywhere. Each SBL would be capable of destroying approximately 100 missiles with the initial fuel load. Capability for on-orbit refueling would be provided. An SBL system could defend against missiles without putting the lives of U.S. military personnel at risk. With its long range and speed of light defense, it accomplishes boost phase intercept at the earliest possible moment, offering the highest probability that intercepted missile fragments (possibly containing active chemical/biological or nuclear materials) will fall within the attackers territory, not on defended assets.

The Directed Energy Program is structured to address the key critical technical issues: (1) Can a chemical laser be built powerful enough to destroy a missile at militarily useful ranges? (Alpha program); (2) Can mirrors and optics be built large enough and easily enough? (Large Aperture Mirror Program (LAMP) and Large Optical Segment (LOS)); (3) Can the high-power beam be controlled adequately? (Large Optics Demonstration Experiment, LODE); (4) Can the high-

power components of a Space Based Laser be integrated on the ground and operated as a system? (Alpha LAMP Integration (ALI)); (5) Can missile targets be acquired and tracked from space and can a laser be pointed and fired accurately enough? (Acquisition, Tracking, Pointing, and Fire Control, ATP/FC); (6) Can these key components be integrated into a functional unit suitable for space flight and remote operation? (Space Based Laser Readiness Demonstrator (SBLRD) Ground Demonstration); and (7) Can the fully integrated system operate adequately on-orbit? (SBLRD).

Progress To Date. The program has demonstrated that the answer to questions 1 through 3 (and partially 5) is "yes," and has built devices that perform the respective functions. (1) The Alpha program's high energy chemical laser achieved weapons-class power for the first time in 1991. (2) LAMP and LOS demonstrated the ability to build optics of the required size with the successful fabrication of a 4-meter segmented mirror in 1989 and a key segment of an 11 meter mirror in 1993. (3) The Large Optics Demonstration Experiment (LODE) demonstrated the ability to control the projected (or outgoing) beam in low power laser experiments in 1987. (5) The basic technology of acquiring and tracking missiles and pointing a high-power laser beam from ground and space has been demonstrated by a number of programs. The ATP/FC technologies required (sensors, optics, processors, etc.) have been demonstrated at or near performance levels required for the Space Based Laser. Stable low power laser beam pointing from a space platform was demonstrated at the same precision level required for an operational SBL in 1991 during the flight of the Relay Mirror Experiment (RME).

Current Status. The major building blocks have been developed, but key system integrations and tests lie ahead. Remaining tasks are: to integrate the high-power laser with the large optics beam director and test (Alpha-LAMP Integration (ALI)); to integrate and test ATP/FC hardware and software (High Altitude Balloon Experiment (HABE)); to integrate the high-power laser and the large optics beam director hardware with ATP/FC hardware and test; to integrate the system in a space qualified SBL Readiness Demonstrator (SBLRD) vehicle for ground and flight testing.

In FY96, Congress provided additional program funding to continue ALI, accelerate design activities for a space demonstration, produce a Concept Of Operations (CONOPS) and design requirements for an operational SBL system, and revitalize the SBL technology development efforts. The increased funding allowed us to preserve vital infrastructure, restore the ALI program to its original scope, and continue the ATP/FC program.

PROJECT NUMBER: 1651
PROJECT TITLE: Innovative Science and Technology
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	**FY98**	**FY99**
0602173C RDT&E	56,009	50,923	50,094
0603173C RDT&E	2,233	0	0

PROJECT DESCRIPIION:
To prepare to meet critical future active defense needs, advanced technology programs invest in an aggressive program of high leverage technologies that yield markedly improved capabilities across a selected range of boost phase and terminal defense interceptors, advanced target sensors, and innovative science. The objectives of these investments are to provide: (1) component technologies that offer improved performance or reduced costs for BMDO acquisition programs; (2) a better understanding of the physical processes to support these acquisition programs; and (3) technical solution options to mitigate unpredicted threats. Unlike other BMDO projects that fund near term technology and testing efforts, this advanced technology initiative invests seed money in high-risk technologies that could significantly change how BMDO develops future systems. The technologies pursued include: next generation sensors, power, information processing, optics, advanced materials, propulsion and communication. This project causes and exploits breakthroughs in science that will keep BMD at the foremost edge of what is possible. A primary project goal is to conduct proof-of-concept demonstrations that transition technology to development programs.

Many of today's baseline technologies on BMDO systems like Theater High Altitude Area Defense (THAAD), PATRIOT Advanced Capability (PAC-3), and Ground Based Radar (GBR) are available due to the wise investment in innovative technologies some 10 years ago. Examples include: indium antimonide and mercury cadmium telluride ultrasensitive infrared detectors; 32-bit radiation hardened Reduced Instruction Set Computer (RISC) processors for image analysis; composite materials for lightweight satellite structures; interferometric fiber-optic gyroscopes for sophisticated guidance and control; and solid-state gallium arsenide transmitter/receivers for BMDO radars. The IST program is the only R&D program in the Defense Department focused on future BMDO technical requirements.

PROJECT NUMBER: 1660
PROJECT TITLE: Statutory and Mandated Programs
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0602173C RDT&E	46,501	51,009	45,394
0603173C RDT&E	4,707	4,161	4,113

PROJECT DESCRIPIION:
To prepare for critical future missile defense needs, advanced technology programs will invest in a balanced program of high leverage technologies that yield improved capabilities across a selected range of boost phase and terminal missile defense interceptors, advanced target sensors, and innovative science. The objectives of these investments are component technologies with improved performance or reduced costs for acquisition programs, and technical solution options to mitigate advanced and unpredicted threats.

Two specific programs in advanced technology are managed under this project:

1. Technology Applications
2. Historically Black Colleges and Universities/Minority Institutions (HBCU/MIs)

The Technology Applications Program, established in 1986, makes technology from all parts of BMDO available to federal agencies, state and local governments, and U.S. business and research interests. The program objective is to develop and support the transfer of BMD derived technology to other Department of Defense applications as well as other federal, state and local government agencies, federal laboratories, universities, and the domestic, commercial, and private sector. Incorporation of these technologies by the private sector and other government agencies can result in reduced unit costs and further improvements to be made available for applications in BMDO systems.

The HBCU/MI Program increases and improves the participation of minority colleges and institutions in the BMDO program. It also responds to Section 832 of PL 101-510 which establishes a specific goal for HBCU and MIs within the overall five percent goal for minority business contracts and introduces them to BMDO technologies and the particulars of the BMDO procurement process.

Each program will focus, to the maximum extent feasible, on innovative technologies in support of future BMD sensor and interceptor systems. These systems will require processing, sensor, power, propulsion, materials and BM/C^3 capabilities beyond those currently being developed. An important goal of each program is to identify, develop, and demonstrate innovative technologies which will dramatically improve BMD system performance.

PROJECT NUMBER: 2160
PROJECT TITLE: TMD Existing System Modifications
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0603872C RDT&E	22,421	12,328	12,957

PROJECT DESCRIPIION:
This project implements nonmajor defense acquisition program modifications to current and existing warning and surveillance systems that result in fielded improvements to TMD capabilities. This project consists of three programs: Cueing and Netting, SHIELD, and the Extended Airborne Global Launch Evaluator (EAGLE).

CUEING AND NETTING. The overarching objective of the cueing and netting task is to enable the U.S. Marine Corps AN/TPS-59 long-range surveillance radar to accept external cues from, and pass cues to, different theater sensors in order to facilitate Theater Ballistic Missile (TBM) identification, location, and tracking. The effort will consist of the development, testing, and operational demonstration of hardware and software improvements to the radar and other supporting systems.

SHIELD (Formerly Talon Shield). The SHIELD program is developing a system that receives and fuses Defense Support Program (DSP) assets, other national intelligence data and SIGINT data on Theater Ballistic Missile (TBM) events to provide more timely warning of worldwide

TBM launch point, time, azimuth and impact point prediction to tactical units. As processing improvements and additional sources are integrated and fused, these upgraded capabilities are passed to the Air Force Attack and Launch Early Reporting to Theater (ALERT) and the Army Joint Tactical Ground Station (JTAGS) programs for incorporation in the operational systems. The system is collocated at the Joint National Test Facility, Falcon Air Force Base, CO with ALERT.

Extended Airborne Global Launch Evaluator (EAGLE). The EAGLE is a Commercial Off The Shelf (COTS) and Nondevelopmental Item (NDI) program that will field a detection, tracking, and cueing system against TBM. EAGLE will be compatible with any Boeing 707 type or larger class aircraft. The prototype is currently planned for installation in the Air Force E-3 Airborne Warning and Control System (AWACS) aircraft. EAGLE represents the integration of several existing technologies into a new sensor suite that will add significant leverage to the overall TBM defense architecture as well as provide significant complementary support to the U.S. and NATO AWACS missions. The principal components of EAGLE are a Wide Area Surveillance Sensor (WASS) from the B-1B program, a High Accuracy Reacquisition Sensor (HARS) from the F-117A Nighthawk program, and a laser range finder from the Navy's Radiant Mist/Outlaw projects. The overall integrator and prime contractor is Boeing in Seattle, Washington. The major subcontractors are Texas Instruments in Dallas, Texas and Rockwell International of California. International participation is at the second tier subcontractors. Operationally, the EAGLE system will acquire a boosting TBM and track it until shortly after burnout to establish very precise trajectory, launch point, and impact point estimates. This information will be broadcast as a Joint Tactical Information Distribution System (JTIDS) message which will be used to cue active defense radar, support attack operations against the launchers, and provide improved warning for passive defense. The trajectory cue will enable fire control radar from a variety of interceptor systems to efficiently focus their energy into a single beam allowing acquisition much sooner than normally achievable with autonomous operations. This capability maximizes the defended area footprint as required by the Joint Requirements Oversight Council (JROC). EAGLE can greatly improve the defended area against long range theater ballistic missiles versus autonomous operation. In addition, the improved situational awareness provided through BM/C^{3}I to the Joint Force Air Component Commander greatly enhances the coordination of the theater air battle and ballistic missile defenses.

FY97 Congressional Language mandated that funding be moved from "TMD Existing Systems - EAGLE" to "Airborne Sensor for Ballistic Missile Tracking". The language also directed the Under Secretary of Defense for Acquisition and Technology (USD(A&T)) provide a plan to congressional defense committees for developing an airborne sensor capability for ballistic missile tracking not later than 19 Jan 97. The language directed that operational user requirements and perspectives and total program cost be given priority consideration in selecting a system to provide this capability. To meet this mandate, the FY97 funds for Task 3 - EAGLE was moved to Task 4 - Airborne Sensor for Ballistic Missile Tracking, the report to Congress written, and program plan developed for the chosen airborne sensor. The EAGLE program will be allowed to proceed at a slower pace due to the funding limitation while the study is conducted and the report written. The Rivet Joint Technology Transfer program will be given initially $400,000 to participate in the study. Depending on the USD(A&T) decision, an airborne sensor may be chosen to proceed through Engineering, Manufacturing, and Development (EMD) and production.

PROJECT NUMBER: 2257
PROJECT TITLE: PATRIOT Advanced Capability-3
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0208865C PROC	219,413	0	0
0604865C RDT&E	381,092	206,057	101,430

PROJECT DESCRIPTION:
PATRIOT is a long-range, mobile, field Army and Corps air defense system, which uses guided missiles to simultaneously engage and destroy multiple targets at varying ranges. The PATRIOT Advanced Capability Level-3 (PAC-3) Upgrade Program is the latest evolution of the phased material change improvement program to PATRIOT. The material changes will provide improved performance across the spectrum for system and threat intercept performance. The material changes include a new PAC-3 missile (previously known as ERINT), remote launch capabilities, communications and computer/software improvements, and radar upgrades to enhance system performance by improving its multifunction capability for tracking, and target handling capability against air breathing, ballistic and cruise missile threats. The PATRIOT operates as lower tier of the Army's Theater Missile Defense (TMD) task force and is developing the capacity to interact with the Navy Cooperative Engagement Capability (CEC) system. PATRIOT is pursuing integration of PATRIOT BM/C^3I with the Project Manager, Air Defense Command and Control Systems to take advantage of previous Army developments that can be incorporated into the PATRIOT program.

PROJECT NUMBER: 2259
PROJECT TITLE: Israeli Cooperative Project
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0603872C RDT&E	43,892	38,715	38,662

PROJECT DESCRIPTION:
This project includes the Arrow Continuation Experiments (ACES) Project, the Arrow Deployability Project (ADP), the Israeli Test Bed (ITB), Israeli Cooperative Research & Development (R&D), and the Israeli System Architecture and Integration (ISA&I) Project. The United States derives considerable benefits from its participation in these projects. The primary benefits are in U.S. gains in technology and technical information that will reduce risks in U.S. TMD development programs. The United States also benefits from the eventual presence of an anti-ballistic missile defense system in Israel, which provides deterrence of future tactical ballistic missile (TBM) conflicts in that region. This defensive system also contributes to a more robust defensive response should deterrence fail.

The Israeli Arrow program consists of efforts to develop a ballistic missile defense system. It includes the U.S.-Government of Israel (GOI) initiative to assist the GOI development of an anti-

tactical ballistic missile (ATBM) interceptor and launcher. The program also includes development of the fire control radar, fire control center and launch control center by the Israelis without U.S. participation. Comprised of three phases, this initiative began with the Arrow Experiments project (Phase I) that developed the preprototype Arrow I interceptor. The ACES project (Phase II) is a continuation of Phase I, and consists of critical lethality tests using the Arrow II interceptor upgraded development and test of the Arrow II interceptor. Arrow provides the basis for an informed GOI engineering and manufacturing decision for an ATBM defense capability. If successful, the Arrow II will satisfy the Israeli requirement for an interceptor for defense of military assets and population centers and will support U.S. technology base requirements for new advanced anti-tactical ballistic missile technologies that could be incorporated into the U.S. Theater Missile Defense (TMD) systems.

The third phase is the ADP which began in FY96. This phase of the project will pursue the research and development of technologies associated with the deployment of the Arrow Weapon System (AWS) and will permit the GOI to make a decision regarding deployment (without financial participation by the United States beyond the R&D stage). This effort will include system-level flight tests of the U.S.-Israeli cooperatively developed Arrow II interceptor supported by the Israeli-developed fire control radar, fire control center and Launcher Control Center (LCC). An interface will be developed for AWS interoperability with U.S. TMD systems. Lethality, kill assessment and producibility will continue to be assessed. Subsequent U.S.-Israeli cooperative R&D on other ballistic missile defense concepts may occur in the future.

The ITB Program is a medium-to-high fidelity theater missile defense simulation that provides the capability to evaluate potential Israeli missile defenses, aids the Israeli Ministry of Defense (IMoD) in the decision of which defense systems to field, provides insights into command and control in TMD, and trains personnel to function in a TMD environment. A structured set of joint U.S./Israeli experiments is being executed to evaluate the role of missile defenses in both mature and contingency Middle East theater operations. This funding also provides for a portion of the operation and maintenance of the ITB and for planned enhancements. Completed experiments identified additional enhancements needed to improve the ITB as an analysis tool. The enhancements incorporated in the ITB to date include radar and weapons models, and a BPI simulation capability. The BPI enhancement benefited the Israeli BPI study completed in January 1996. The planned Adaptive Battle Management Center (ABMC) enhancement will benefit the United States by enabling the ITB to simulate a wide variety of command and control and interoperability issues.

The Israeli Cooperative R&D program supports the advancement of emerging TMD technologies. This support will advance the technology demonstration phase which will provide for the defense of the State of Israel. It further supports the U.S. technology base needs for these technologies, and furthers the pursuit of interoperability with U.S. TBMD systems. This task supports efforts in developing an interface to allow for interoperability between Israeli TMD systems and U.S. TBMD systems and the implementation of such a system.

The ISA&I tasks provide ongoing analysis and assessment of the baseline, evolutionary, and responsive threats to support the definition and evaluation of an initial Israeli Reference Missile Architecture (IRMA), a baseline missile configuration. Evolutionary growth paths to enhance the IRMA robustness against future threats will be identified. Critical TMD system architecture issues and technologies will be analyzed, and the conformance to established requirements of var-

ious Israeli Anti-tactical Ballistic Missile (ATBM) programs, including the Arrow missile development activity, the ADP, and the ITB will be conducted. Finally, previously developed simulations and models will be used selectively to address significant TMD issues. Collectively, the tasks conducted under this cooperatively sponsored ISA&I project will provide critical insights and technical data to both the U.S. and Israeli governments for improving near term and evolutionary defenses against ballistic missile threats.

Since program initiation in 1988, Israel successfully improved the performance of its pre-prototype Arrow I interceptor to the point that it achieved a successful intercept and target destruction in June 1994. Arrow II design and component testing progressed to the successful demonstration of the new warhead, electro-optical seeker, radar fuse, first stage booster, sustainer booster, launcher canister, and launcher. The ADP International Agreement was signed in March 1996 and Presidential certification was completed in May 1996.

The ITB became operational in the second quarter of FY92. The ITB experiments validated the performance of the prospective near term Israel Theater Missile Defense System. It provided valuable insight into the potential role of Human-In-The-Loop (HIL) for a TMD system. Also, the Test bed Product Office at the Space and Strategic Defense Command benefited from the application of ITB Project experience to the U.S. and United Kingdom Extended Air Defense Test Bed (EADTB) Projects.

The ISA&I Project activities demonstrated that defense of the State of Israel from tactical ballistic missile (TBM) attacks is feasible and cost-effective. The ISA&I effort analyzed and addressed numerous TMD system issues including HIL, resource allocation, and threat analysis. The United States benefited from the architecture analysis work, including identification and progress toward resolution of critical TMD system issues such as kill assessment and the lethality study of a novel interceptor warhead.

PROJECT NUMBER: 2260
PROJECT TITLE: THAAD System
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	**FY98**	**FY99**
0603861C RDT&E	341,307	294,647	16,778
0604861C RDT&E	277,508	261,480	578,467
0604861C MILCON	0	4,565	0

PROJECT DESCRIPTION:

The Theater High Altitude Area Defense (THAAD) System is being designed to negate theater ballistic missiles (TBM) at long ranges and high altitudes. Its long-range intercept capability will make possible the protection of broad areas, dispersed assets, and population centers against TBM attacks. The THAAD System includes missiles, Palletized Loading System (PLS) launchers, Battle Management/Command, Control, Communications, Computers, Intelligence (BM/C^4I) units, THAAD Radars, and support equipment. The THAAD Radar (formerly known as Ground Based Radar) provides threat early warning, threat type classification, interceptor fire control, external sensor cueing, and launch and impact point estimates for the THAAD System. The THAAD

Radar is based on state-of-the-art, solid-state, X-band radar technology. THAAD will be interoperable with both existing and future air defense systems. This netted and distributed BM/C^4I architecture will provide robust protection against the TBM threat spectrum. THAAD is pursuing integration of THAAD BM/C^4I with the Project Manager (PM), Air Defense Command and Control Systems (ADCCS) to take advantage of previous Army developments that can be incorporated into the THAAD program.

The Demonstration/Validation (Dem/Val) program will develop a design for the objective THAAD system and demonstrate the capabilities of the system in a series of 11 flight tests. The residual hardware resulting from the THAAD Dem/Val program, including the User Operational Evaluation System (UOES) missile option, will be used for a prototype system called the UOES. The UOES, used primarily for early operational assessment and for soldiers to influence the final design, will also be available for limited use as a contingency capability during a national emergency. The UOES will consist of 40 missiles with 4 launchers, 2 BM/C^4I units, 2 THAAD Radars and support equipment. The THAAD system design will be developed and tested in the Engineering, Manufacturing, and Development (EMD) phase leading to low rate initial production and subsequent fielding in FY04.

During FY95-98 the Dem/Val flight test program will be conducted at White Sands Missile Range (WSMR), New Mexico. The flight test schedule consists of flight and system tests which began on April 21, 1995 with a successful first flight of the THAAD missile. To date, six flight tests have been conducted with the seventh flight planned for February 1997. The targets for the flight test program are being developed under the Tactical Missile Defense Targets contract (Project 3354).

This project is assigned to the Budget Activity and Program Element codes as identified in this descriptive summary in accordance with existing Department of Defense policy.

The THAAD Program continued Dem/Val hardware and software design, development and delivery in support of integration and acceptance testing for flight testing at WSMR. The first Dem/Val THAAD radar was delivered to WSMR on July 17, 1995, and has participated in flights 3, 4, 5, and 6. The THAAD Dem/Val Radar has performed in the shadow mode to the test range radar and will be the primary sensor on flight 7. The first UOES Radar was delivered to WSMR May 3, 1996, and completed range integration and test in September 1996. It will be used for flight testing beginning with flight 8 and for the remainder of the Dem/Val flight tests. The first flight was successfully conducted at WSMR on April 21, 1995, proving the THAAD missile propulsion system booster/kill vehicle separation, seeker shroud cover deployment, seeker data, uplink/downlink communications from the Radar Interface Unit (RIU) to the missile, and preplanned command destruct. The second flight was conducted on July 31, 1995, as a planned non-intercept, guidance and control test. The missile successfully performed the THAAD Energy Management Steering (TEMS) maneuver which resulted in nominal velocities and accelerations. The kill vehicle successfully maneuvered in response to planned In-Flight Target Updates (IFTUs). The third flight was a non-intercept fly-by test against a Storm target on October 13, 1995. The missile collected critical seeker data and the BM/C^4I generated the fire control solution and sent the launch command to the interim launcher. During flight 4, on December 13, 1995, much success was demonstrated even though a planned intercept was not accomplished. The PLS launcher was used successfully for the first time, and the seeker and integrated electronics package demonstrated end game homing. During flights 4, 5, and 6, the THAAD Radar successfully tracked both the

THAAD interceptor and the target. During flights 4 and 6, it properly maintained track on the interceptor and seeker shrouds during shroud separation. All radar mission events, times, and durations went as predicted in pre-mission analysis. Flight 6 was conducted July 15, 1996. Data analysis is being performed to assess the segment performance which all appeared to function as planned, with the exception of a component failure in the missile seeker. An intercept was not achieved, however, critical data was obtained on how the seeker viewed the target.

PROJECT NUMBER: 2263
PROJECT TITLE: Navy Area TMD (Lower Tier)
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0208867C PROC	9,151	0	0
0603867C RDT&E	59,315	0	0
0604867C RDT&E	241,330	267,822	226,748

PROJECT DESCRIPTION:
The Navy Area Theater Ballistic Missile Defense (TBMD) project builds on the national investment in AEGIS ships, weapon systems, and Navy Standard Missile II (SM-2) Block IV missiles. Two classes of ships continue to be deployed with the AEGIS combat system: the CG-47 Ticonderoga-class cruisers and the DDG-51 Burke-class destroyers. Navy TBMD will take advantage of the attributes of naval forces including overseas presence, mobility, flexibility, and sustainability in order to provide protection to debarkation ports, coastal airfields, amphibious objective areas, Allied forces ashore, and other high value sites. Navy assets will provide an option for initial TBMD allowing the insertion of additional land-based TBMD assets and other expeditionary forces in an opposed environment.

PROJECT NUMBER: 2358
PROJECT TITLE: HAWK System BM/C^3
PROGRAM ELEMENT/FUNDING ($ in Thousands)

	FY97	FY98	FY99
0208863C PROC	14,665	0	0

PROJECT DESCRIPTION:
The program consists of modifying the U.S. Marine Corps AN/TPS-59 long-range air surveillance radar and the HAWK weapon system to allow detection, tracking, and engagement of short-range TBMs and thereby provides a point defense Theater Missile Defense (TMD) capability to the Marine Air Ground Task Force. The program will also provide a communications interface between the AN/TPS-59 and the HAWK system by developing an Air Defense Communications Platform (ADCP). This Marine Corps TMD initiative is jointly funded with BMDO and will yield a low-risk, near-term capability for expeditionary forces against short-range ballistic missiles.

The AN/TPS-59 long-range surveillance radar is the primary sensor for the Marine Air Control Squadron. The (V3) configuration developed under this program was enhanced to provide a TBM tracking and surveillance capability. The radar completed operational test and evaluation in FY96 and initial modification kit production will begin in FY97. Installation of the modification kits is scheduled to begin in FY98 and complete in FY99.

The HAWK weapon system modifications include upgrades to the Battery Command Post (BCP) and improvements to the HAWK missile that resulted in a missile configuration called the "improved lethality missile." The modified HAWK BCP will process cueing data to control the high-power illuminator radar. The improved lethality missile will incorporate fuse and warhead improvements to 300 improved lethality missiles that have been transferred from the Army to the Marine Corps. Another 700 improved lethality missile modification kits will be procured and installed by the end of FY97. Production of the BCP modification kits began in FY95 and the installation of all BCP modifications was completed by the end of FY96.

The Air Defense Communications Platform (ADCP) will convert AN/TPS-59 data messages and Tactical Data Information Link-J (TADIL-J) formatted messages into the intra-battery data link formats required by the HAWK weapon system. The ADCP will also transmit TADIL-J formatted messages to other theater sensors. This communications interface has completed operational test and evaluation and initial production will begin in FY97. Fielding of the ADCP is scheduled to begin in FY98 and complete in FY99.

This project is assigned to the Budget Activity and Program Element codes as identified in this descriptive summary in accordance with existing Department of Defense policy.

PROJECT NUMBER: 2400
PROJECT TITLE: National Missile Defense
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0603871C RDT&E	828,864	504,091	393,085

PROJECT DESCRIPTION:
The objective of the National Missile Defense (NMD) program is to develop and maintain the option to deploy a cost effective, operationally effective, and Anti-Ballistic Missile (ABM) Treaty compliant system that will protect the United States against limited ballistic missile threats, including accidental or unauthorized launches or Third World threats. In mid 1993, the Department of Defense (DoD) conducted a Bottom-Up Review (BUR) to select the strategy, force structure, and modernization programs for America's defense in the post-Cold War era. With the dissolution of the Soviet Union, the threat to the U.S. homeland from a deliberate or accidental ballistic missile attack by states of the former Soviet Union (FSU) or the Peoples Republic of China (PRC) was judged to be highly unlikely. In addition, the ability of Third World countries to acquire or develop a long range ballistic missile capability in the near future was considered uncertain. As a prudent approach for responding to this uncertain threat, the Department pursued a technology readiness strategy for National Missile Defense (NMD) to develop and maintain the ability to deploy ballistic missile defenses for the United States should a threat emerge.

In February 1996, the Department completed a comprehensive Ballistic Missile Defense Program Review that addressed changes that have occurred in the ballistic missile defense environment since the 1993 BUR. For the NMD program, the findings of this review resulted in an adjustment to the goal of the NMD program and a corresponding adjustment to the Future Years Defense Program which now includes additional resources in FY96-98 for NMD. The revised goal of the NMD program is to develop, within three years, elements of an initial NMD system that could be deployed within three additional years after a deployment decision. This approach is commonly referred to as the NMD "3+3" program. The path towards accomplishing this goal includes: providing a near term focus to reduce program risk; providing a hedge against the potential of more sophisticated emerging threats; and conducting an integrated NMD system test not later than FY99. All development efforts will be broadly based to preserve deployment option flexibility for a future decision on deployment of an ABM treaty compliant NMD system.

To achieve this goal, BMDO has initiated an NMD Deployment Readiness Program. In April 1996 the USD(A&T) initiated steps to designate NMD as an Acquisition Category (ACAT) 1D program and in July 1996 the program successfully completed its first Overarching Integrated Product Team (OIPT) review. The intent of the NMD Deployment Readiness Program is to position the U.S. to respond to a strategic missile threat as it emerges by shifting emphasis from technology readiness to deployment readiness. This approach focuses on demonstrating an NMD system level capability by FY99, and being able to deploy that capability within an additional three years, if required to do so by the threat. If no threat materializes at the end of the three year development period, evolutionary development will continue on a path towards an objective system capability and the program will continue to maintain the ability to deploy within three years after a decision is made to do so. With this approach, no commitment to deploy is made until the threat emerges.

The NMD system is composed of several elements which are required to perform the key functions involved in a ballistic missile defense engagement. The Ground Based Radar (GBR) and the Space Based Infrared System (SBIRS) Low component (previously known as the Space and Missile Tracking System) provide the dual sensor phenomenology required to address the full spectrum of potential threats. In addition, Upgraded Early Warning Radars (UEWR) are candidate sensors in the event of an early NMD deployment within three years of the FY99 NMD integrated system test. SBIRS, which will provide midcourse tracking of targets, is currently managed and funded by the Air Force. The Ground Based Interceptor (GBI) is the weapon element that engages and destroys the threat. The Battle Management/Command, Control, and Communications (BM/C^3) element provides engagement planning and human-in-control management of the engagement.

Concurrent with the development of these elements, technology development efforts focused on achieving an early NMD capability and providing a path to future enhanced capabilities are being prioritized and funded to the extent possible. In addition, several related activities are being performed in support of the development of the NMD system. System Engineering develops the NMD system-level performance and integration requirements and flows these requirements down to the individual elements. NMD Integration activities integrate the individual elements into a unified and coordinated NMD system. Deployment Planning activities focus on the planning required to field the NMD system. Test and Evaluation activities provide management of the NMD T&E program. And Program Support provides overall program management and analysis support. All NMD activity areas are described in more detail below.

GBR is the primary fire control sensor, providing surveillance, acquisition, tracking, discrimination, fire control support and kill assessment for the NMD system. Prior to commitment of interceptors, the radar performs surveillance autonomously or as cued by SBIRS Low or other sensors, and will acquire, track, classify/identify and estimate trajectory parameters for targets. In post-commit, the radar will discriminate and track the target(s), and provide via the In-Flight Interceptor Communications System (IFICS) an In-Flight Target Update (IFTU) and a Target Object Map (TOM) to the interceptor(s). The GBR is an incremental development program derived from the former NMD-GBR program and will leverage the Theater Missile Defense GBR program to resolve the critical radar issues applicable to NMD. A GBR prototype, designated as GBR-P, will be installed at USAKA in FY98 and will be available as part of the FY99 NMD integrated system test (IFT-5).

Upgraded Early Warning Radars incorporate the software upgrades and modest hardware changes required by the existing Early Warning Radars to support the NMD mission. The UEWRs will detect, track and count the individual objects in a ballistic missile attack early in their trajectory. The UEWR data can be used for interceptor commit and GBR cueing in the event of an early deployment. Depending on the anticipated threat (East Coast or West Coast) at the time of a defense deployment decision, the appropriate BMEWS and/or PAVE PAWS radars will be upgraded for inclusion in the NMD architecture. If needed, other existing forward based radars (such as Cobra Dane or HAVE STARE) could also be used to support NMD.

The Ground Based Interceptor is using an evolutionary acquisition strategy to develop and demonstrate the NMD interceptor capability, with an emphasis on accomplishing the NMD integrated system test in FY99. The initial focus of GBI development is the Exoatmospheric Kill Vehicle (EKV) which is the most critical and technically challenging part of the GBI. Development of an EKV booster and the associated launch control equipment will begin in FY98. Until booster development is complete, EKV flight tests will be flown on the Payload Launch Vehicle (PLV), which is a booster consisting of a Minuteman II second and third stage. EKV sensor flight tests are scheduled for FY97 and EKV interceptor flight tests are scheduled for FY98 and FY99. The two current EKV contractors will be down selected to one in FY98.

The Battle Management, Command, Control And Communications activity uses an evolutionary approach to incrementally prototype the BM/C^3 functionality required for the NMD mission, and integrate and demonstrate an NMD system in step with evolving NMD sensors and interceptor element capabilities. BM/C^3 prototypes will be integrated and demonstrated at the Joint National Test Facility (JNTF) with USSPACECOM/NORAD user participation to refine and focus the BM/C^3 development and system behavior. NMD BM/C^3 supports the NMD command and control process required to provide human-in-control; develop, assess, and select missile defense strategies and tactics; fuse and correlate available sensor information for discrimination; integrate and plan the complimentary coordination of NMD sensors and interceptors for maximum system performance and kill assessment; provide interface with existing and planned C3 systems; prototype an In-flight Interceptor Communications System (IFICS) for BM/C3-GBI communication.

System Engineering translates user requirements into NMD system-level performance and integration requirements and flows them down to the individual program elements. This results in a balanced system capability, and readiness through incremental element development on a path to an objective system deployment capability. Throughout this process, systems engineering inter-

acts with and ultimately defines the architecture required to meet and defeat whatever the prescribed threat may be. System engineering is an integral part of the components performance verification, test planning and analysis, deployment planning, user concept of operations (CONOPS) development and evaluation, and command and control (C2) simulation analysis activities. This effort includes interaction with the user with respect to operational requirements, CONOPS, integration of multi-sensor systems, and operational evaluation of R&D activities in support of command and control (C2) simulations. Analyses, simulations, and tests are performed to address the system effectiveness and concept of operations of proposed NMD system architectures against near and far term ballistic missile threats. These results support activities required for strategic C2 simulations where the CINCs identify roles, missions and requirements for an effective NMD system.

NMD Integration activities focus on integrating the individual NMD elements into a cohesive NMD system. The Lead System Integrator (LSI) will have responsibility for integrating the GBI; developing, integrating and demonstrating the NMD system; and developing NMD deployment options. Parallel concept definition study contracts will be awarded in FY97, with down select and contract award to a single LSI contractor in FY98.

Deployment Planning activities focus on planning and logistics activities which support a decision to deploy, and the deployment of the NMD system if a deployment decision is made. The deployment planning effort will be captured in the NMD Integrated deployment Plan. Deployment planning activities also include the identification of critical actions and timelines for fielding the NMD system, the identification of actions that would mitigate the risks to deployment, and initial planning for life cycle logistics support. Other efforts include environmental analyses and documentation, site activation planning, human systems integration, site analyses, industrial base assessments and operational suitability assessments.

Test And Evaluation activities involve providing the planning and management to support the NMD test and evaluation program. Some test infrastructure is provided including the Integrated System Test Capability (ISTC) for NMD HWIL testing and simulation activities, and development and validation of targets for NMD sensor and EKV intercept tests. Planning includes overseeing the development and coordination of documentation essential to the conduct of testing -- the overall test strategy, the Cost Analysis Requirements Document (CARD), detailed test plans, interface control documents, lethality plans, posttest data analysis plans, and simulation Validation, Verification and Accreditation (VV&A). Management activities include development of the NMD Test and Evaluation Master Plan (TEMP), review and analysis of test results, and coordination of test assets.

Sensor Technology focuses on the development of advanced technologies in infrared focal planes, cryogenics, radiation hardened electronics and signal processing, and optics hardware for the objective SBIRS Low satellite system. Research and development of components, devices and subsystems required for the SBIRS Low system will continue, supportive technologies in infrared focal plane testing, cryocooler development and radiation testing of electronics and optics hardware will be pursued.

Program Support provides management and analysis support to the NMD programs in areas such as cost/schedule/performance assessments, cost estimating and analysis, budget analysis and for-

mulation, program planning and control, and contract management.

Other NMD Initiatives addresses the USAF NMD initiative to fully explore the USAF NMD concept, including utilizing test facilities which provide a realistic and representative test scenario. Specific activities remain under review but may include performing sensor track/data fusion, transmitting in-flight target updates and target object maps to an interceptor, acquiring targets with a sensor package, and demonstrating that the launch control system meets or exceeds NMD timeline requirements.

Phenomenology provides the U.S. with the capability to generate high confidence target signatures for ballistic missile defenses. This is a critical adjunct to the design and evaluation of NMD system performance across the full spectrum of threats and engagement scenarios. This program provides signature collection sensors for live-fire missions and storage of the resulting test data. This program provides predictive models of target signatures and develops algorithms for the critical functions of discrimination, target handover and aim point selection.

Architecture Analysis/BM/C^3 Initiatives supports an initiative to ensure that system architecture and BM/C^3 are addressed in a coordinated and synergistic manner across all NMD and TMD efforts. Systems analysis work is done to determine the expected operational effectiveness and life cycle cost impacts of the NMD system based on changing threats, mission requirements, acquisition reform initiatives and advances in technology. It includes implementation within BMDO of DoD initiatives in C4ISR architectures, technical architecture and open systems.

Threat And Countermeasures defines potential adversary missile forces which the NMD system could confront. This includes: (1) Intelligence threat description in the form of an annual report, the NMD System Threat Assessment (NMDSTA); (2) Threat scenario generation; and (3) Countermeasure integration, which integrates countermeasures (CM) technology into NMD elements.

Modeling And Simulation provides for the development and validation of modeling and simulation (M&S) tools and techniques. This project provides supercomputing resources at the Joint National Test Facility (JNTF) and the Advanced Research Center/Simulation Center (ARC/SC), and the engineering expertise and integration support to operate these facilities.

Test Resources provides the infrastructure to support the NMD test and evaluation program. Test infrastructure includes common test ranges and instrumentation, and common test beds for NMD HWIL testing and simulation activities. Common ground test facilities include: Kinetic Kill Vehicle Hardware-in-the-Loop Simulator (KHILS) at Eglin AFB, FL; Hypervelocity Wind Tunnel Number 9 at the Naval Surface Warfare Center, White Oak, MD; National Hover Test Facility (NHTF) at Edwards AFB, CA; Kinetic Energy Weapon Digital Emulation Center at Huntsville, AL; Aero Optic Evaluation Center (AOEC) at Calspan Corp, Buffalo, NY; Center for Research Support (CERES) at Falcon AFB, CO; Army Missile Optical Range (AMOR) at Huntsville, AL; 7V and 10V chambers at Arnold Engineering Development Center (AEDC) in Tullahoma, TN; Portable Optical Sensor Tester (POST) and Characterization of Low Background Mosiacs (CALM) at Rockwell International in Anaheim, CA; Naval Research and Development (NRaD) at the Naval Command, Control and Ocean Surveillance Center in San Diego, CA; and infrared and blackbody standards at the National Institute of Standards and Technology (NIST) in Gaithers-

burg, MD. Common range facilities include Kwajalein Missile Range (KMR) in the Marshall Islands; Western Test Range (WTR) at Vandenburg AFB, CA; and the Pacific Missile Range Facility (PMRF) at Kauai, HI. Common range instrumentation includes special test equipment, data collection assets and range instrumentation upgrades including: High Altitude Observatory (HALO) with the Infrared Imaging System (IRIS) based at Aeromet, Inc. in Tulsa, OK; the Remote Area Safety Aircraft (RASA) based at Point Mugu, CA; the SeaLite Beam Director (SLBD) at White Sands Missile Range, NM; KMR improvements and modernization; and the Kwajalein Mobile Range Safety System (KMRSS).

OPERATIONAL SUPPORT provides personnel and related support costs common to all NMD projects including support to the Office of the Director, Ballistic Missile Defense Organization (BMDO) and his staff located in Washington, DC, as well as BMDO's Executing Agents within the U.S. Army Space and Strategic Defense Command, U.S. Army PEO Missile Defense, U.S. Navy PEO for Theater Defense, U.S. Air Force PEO office and the Joint National Test Facility. This project supports funding for overhead/indirect personnel costs, benefits and infrastructure costs such as rents, utilities and supplies.

This project is assigned to the Budget Activity and Program Element codes as identified in this descriptive summary in accordance with existing Department of Defense policy.

PROJECT NUMBER: 3153
PROJECT TITLE: Architecture Analysis and BM/C^3 Initiatives
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0603872C RDT&E	6,799	8,273	8,099

PROJECT DESCRIPTION:
This project, which began in FY95, supports two offices within BMDO to ensure that appropriate issues relating to system architecture and Battle Management/Command, Control, and Communications (BM/C^3) are addressed in a coordinated and synergistic manner across all BMDO National Missile Defense (NMD) and Theater Missile Defense (TMD) efforts. The offices of Architecture Integrator and the BM/C^3 Office report directly and independently to the BMDO Director to provide the necessary mission-area oversight of critical BMDO technical issues.

In this project, BMDO supports systems analysis work to determine the expected operational performance and effectiveness of missile defense systems under development. Computer simulation models are developed and used to investigate architecture and system level capability and to resolve critical technical issues related to the development of specific elements of the architecture. Tradeoffs in alternative elements, specific designs, inventory and integration of systems are conducted in detail to determine the most cost effective approach for a particular missile defense mission. The work is performed on a continuing basis in order to determine the impact of changing threats, mission requirements, and advances in technology. The project provides BMDO with an independent assessment of the expected effectiveness of major programs under development and requirements for supporting technology. The work is separated into two program elements, one

for TMD and the other for NMD.

In this program element the focus is on TMD systems and technology. The primary thrust of the work is to show, through analysis, the need for and the expected performance of different defense systems under development to handle current and projected missile threats, both ballistic and cruise. Issues such as warhead lethality, system degradation in a severe countermeasure environment, target handover from tracking sensor to missile seeker, effects of netting sensors, etc. are some of the technical issues addressed in this project.

Future BM/C^3 activities in this project will provide for the mission area oversight and coordination of all BMDO BM/C^3 development and acquisition activities. This effort will provide for the synergistic evaluation of relevant BM/C^3 technical issues; the formulation of appropriate plans, programs, and policies to facilitate the coordination of all BMD Advanced Development BM/C^3 research, development, and acquisition activities across TMD and NMD program activities; promote appropriate reuse strategies to maximize BMD reuse capabilities; and minimize the duplication of BM/C^3 research and development efforts across all NMD and TMD development efforts.

PROJECT NUMBER: 3157
PROJECT TITLE: Environment, Siting, and Facilities
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	**FY98**	**FY99**
0603872C RDT&E	5,972	3,600	3,640
0603872C MILCON	1,404	1,965	1,885

PROJECT DESCRIPTION:
Provides environmental program guidance, environmental impact analyses and documentation, real property facility siting, acquisition, and facility operational support for the Ballistic Missile Defense Organization (BMDO) Theater Missile Defense (TMD) system. Plans, programs, budgets, and oversees facility acquisition through the Military Construction (MILCON) and RDT&E construction programs. Provides guidance and supports BMDO TMD Environmental Assessment and Environmental Impact Statement process, environmental compliance, pollution prevention, and other environmental efforts for TMD activities. Develops guidance for Executing Agents on facilities, siting, acquisition, and environmental matters.

PROJECT NUMBER: 3160
PROJECT TITLE: TMD Readiness
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	**FY98**	**FY99**
0603872C RDT&E	1,709	1,730	1,692

PROJECT DESCRIPTION:

This project supports Theater Missile Defense projects in the functional areas of manufacturing, logistics supportability and metrology design and support. These diverse functions map directly into meeting operational suitability and affordability goals. By focusing on all TMD (BMD) activities and coordinating these efforts between the Services and projects, common cost avoidance is realized. TMD readiness activities include producibility and planning for manufacturing, acquisition logistics, metrology, and training. The efforts will concentrate on identifying and analyzing critical TMD systems level deployment, support, Producibility and Manufacturing (P&M) risks, industrial base capability issues and developing mitigation plans for these areas to ensure operational requirements and BMDO affordability objectives are met. In addition, TMD operational suitability and availability advances and lessons learned are applied to NMD projects. This effort will also focus on the identification of critical TMD metrology requirements; and the development of national/DOD measurement standards and calibration support for TMD technology and acquisition programs.

PROJECT NUMBER: 3251
PROJECT TITLE: Systems Engineering and Technical Support
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0603872C RDT&E	50,909	65,260	62,031

PROJECT DESCRIPTION:

This project provides system engineering and technical support for the integration of Service-supplied weapon systems to facilitate the identification and resolution of inter-Service integration and interoperability issues; technical and engineering assessments and trade-off studies of Theater Missile Defense (TMD) system architectures and concepts; support for U.K. developed sensor data fusion methodology; Ballistic Missile Defense (BMD) system survivability oversight and assessment; risk reduction and acquisition streamlining support; modeling, simulation, experiment, and flight test support; development and maintenance of technical and programmatic databases; and preparation of technical reports, briefings, and programmatic documentation associated with TMD studies and critical issues.

PROJECT NUMBER: 3261
PROJECT TITLE: TMD BM/C^{3}I (BM/C^{3}I Concepts)
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0208864C PROC	19,696	0	0
0603872C RDT&E	32,357	34,094	35,864

PROJECT DESCRIPTION:

The primary mission of this project is to provide the warfighter with an integrated and interoperable Theater Missile Defense (TMD) Battle Management/Command, Control, Communications,

and Intelligence (BM/C^{3}I) capability having the flexibility to meet a wide range of threats and expected needs. The BM/C^{3}I architecture for TMD is built upon the existing command and control (C2) structure for Theater Air Defense (TAD) and adds the communications linking TMD C2 nodes, weapons, and sensors, and the TMD interfaces to intelligence systems and other supporting capabilities. The BMDO, from its joint perspective, uses this project to oversee independent weapon systems development and to provide guidance, standards, equipment, integration, and analysis to maximize the performance of a multitude of sensors, interceptors, and C2 nodes and to synergize their individual contributions to an integrated Joint theater-wide TMD system. BMDO has three major thrusts to the TMD BM/C^{3}I integration program.

The first thrust establishes the links and means for receipt of and in-theater dissemination of early warning and launch warning information from space-based and intelligence systems external to TMD. This project supports the system engineering of their capability and prototype development of items such as improved displays for early in-theater warning information. This project focuses on linking separate external systems into the theater.

The second thrust of the BM/C^{3}I program focuses on communication and interoperability among TMD weapon systems. Interoperability includes both the communications equipment, and protocols as well as the common command and control procedures among different weapons systems to ensure a truly integrated theater-wide ballistic missile defense system. The cornerstone of TMD interoperability is the Joint Data Net (JDN) which uses the Joint Tactical Information Distribution System (JTIDS) and the Tactical Data Information Link-JTIDS (TADIL-J) message format. This project integrates JTIDS terminals into existing Theater Ballistic Missile Defense (TBMD) C2 platforms and provides the necessary software upgrades. This funding is critical for timely inter-Service interoperabiltiy.

The third thrust of the BM/C^{3}I program directs attention to upgrades of Service C2 centers. Various command center upgrades are included in this project to reduce decision-making time necessary to effectively engage ballistic missiles. Again, BMDO leverages off several existing Service-funded theater air defense command center upgrades and this project funds only the specific TMD-related aspects of these upgrades. BMDO's central direction and support of hardware and software developments will produce an integrated C2 capability for TMD.

The joint warfighters and BM/C^{3}I developers evaluate the effects of early warning, improved interoperability, integration, and command center upgrades on joint TBMD doctrine through BM/C^{3}I work shops and analysis.

All of the efforts in this project are designed to provide a seamless interoperable architecture to provide timely warning and information necessary to reduce decision times and allow more opportunities to efficiently and effectively engage hostile missiles. The end result will kill more missiles and will reduce casualties to U.S. and other friendly forces.

PROJECT NUMBER: 3265
PROJECT TITLE: User Interface
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0603872C RDT&E	14,031	14,680	21,976

PROJECT DESCRIPTION:

This project provides the Joint Staff and the warfighting Commanders-in-Chief (CINCs) with the means to ensure that the Theater Missile Defense (TMD) development reflects evolving military needs and the combined warfare capabilities of allies and friends. To accomplish this, there must be clearly articulated tactics, doctrine, policies, and procedures. The three areas which provide the information base to effectively transition TMD capabilities into the existing and planned operational activities and war plans are described below.

The project's primary area is focused on the refinement of existing and near term TMD capabilities. This is accomplished through the CINC's TMD Assessments Program, which involves the execution of numerous operationally realistic military exercises. These exercises provide the basis for the assessment, development, and improvement of TMD capabilities. Specific activities include the integration of new technology and hardware into the CINC operations, and the integration of User Operational Evaluation Systems (UOES) to examine the effectiveness of architectures and operational concepts. UOES is a prototype operational system of hardware and procedures which will be user operated for field evaluation purposes. Through the Assessments Program, the CINCs develop Battle Management Command, Control, and Communications (BM/C^3) architectures, formulate and test operational concepts, and determine or refine operational requirements. This program exercises communications architectures and develops operational concepts that will enable rapid integration of the PATRIOT Advanced Capability (PAC-3), Theater High Altitude Area Defense (THAAD), and Navy Area Theater Ballistic Missile Defense (TBMD) into the theater's warfighting capability. In future years, the CINCs' TMD Assessment Program will continue to develop ways to improve the CINCs' warfighting capabilities and integrate emerging TMD capabilities through simulation and employment of UOES hardware. Within the context of Combined Warfare, the Assessments Program focuses on providing the means for the U.S. and its allies to develop an understanding of each other's doctrine and common concepts of operation, and to determine equipment compatibility and interoperability.

The second area focuses on understanding the changing threat and how to best counter that threat. This is accomplished through the conduct of Warfare Analysis Laboratory Exercises (WALEX). Relying primarily on computer simulation tools and real experiences from the CINC's Assessment program, these exercises are performed to educate the TMD development community concerning the challenges presented by the theater missile threat. The WALEX provide forums for discussion of complex issues associated with concepts of operation for existing and future capabilities.

The third area focuses on the integration of warfighter operational requirements with near and far term Ballistic Missile Defense (BMD) program development. TMD programs (e.g., THAAD, Navy TBMD, etc.) are in various stages of development, and are scheduled for future deployment. This project area ensures that the experiences gleaned from such programs as the CINC's Assessment program are factored into all TMD programs. These programs are to develop and acquire TMD systems and architectures to (a) deploy theater missile defense capability to protect forward-deployed armed forces of the U.S., friends, and allies; and, (b) demonstrate advanced technologies for near-term insertion options and concept development of new systems. Analyses and simulations address systems effectiveness of proposed TMD system architectures against ballistic

missile threats to U.S. deployed forces, our allies and friends. Analytical results are also used to support activities required for the Defense acquisition process. Theater gaming with the CINCs is also supported to identify roles, missions, and requirements for TMD.

PROJECT NUMBER: 3270
PROJECT TITLE: Threat and Countermeasures Program
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0603872C RDT&E	21,419	27,986	29,154

PROJECT DESCRIPTION:
Threat and Countermeasures Program. The BMDO Theater Missile Defense (TMD) Threat Program defines potential adversary military forces, principally Theater Ballistic Missile (TBM) threats. To accomplish this mission, BMDO has a threat development program which is based on intelligence community projections and is traceable to quantifiable analysis. This project produces capstone threat and countermeasure documentation to ensure consistent technical threat definitions across all the Services. It does not duplicate Service-unique activities. The program consists of three component tasks: Intelligence Threat, Countermeasures Integration, and System Threat Scenario Generation.

PROJECT NUMBER: 3352
PROJECT TITLE: Modeling and Simulations
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0603173C RDT&E	2,002	1,554	1,898

PROJECT DESCRIPTION:
This project provides for the development/modification and validation of Modeling and Simulation (M&S) techniques and tools that are critical in assessing the projected, alternative, and demonstrated performance capabilities of Theater Missile Defense (TMD) and National Missile Defense (NMD) systems. These large and complex M&S tools require high-performance vector and parallel processing supercomputers, scalar processors, and advanced graphic workstations for operation. Portions of this processing capability are housed at the Joint National Test Facility (JNTF) in Colorado Springs, CO, and the Advanced Research Center/Simulation Center (ARC/SC) in Huntsville, AL. These facilities operate in a distributed integrated simulation environment and host the modeling and simulation war games that provide analysis, integration, demonstration, and performance verification of Ballistic Missile Defense (BMD) systems. These facilities and the Joint Missile Defense Network (JMDN), which links BMD contractors, Services, and other DoD government facilities, are utilized by all Services. Procedures are established to ensure efficient utilization of these facilities and to provide Verification, Validation, and Accreditation (VV&A) of the models, simulations, and systems portrayed. This cost-effective approach reduces the need for more costly live fire missile test programs and establishes requirements for future

technology needs. It promotes enhancements of M&S technologies that support: the acquisition process; the development of fielding of operational capabilities; and the development of common tools, methodologies, and protocols beneficial to data exchange, integration of various models and simulations, and software reusability of M&S applications.

Funding for these facilities is distributed through Project 3352. Three Program Elements (PEs) (NMD, TMD, and Support Technology) provided funding. This cost sharing approach ensures cooperation, contributes to achieving synergy across the efforts, and minimizes duplication of modeling and simulation resources. The total funding profile remains flat on an annual basis, with adjustments for inflation. For example, the decrease in TMD funding for JNTF in FY97 is offset by a corresponding increase in NMD funding. These PEs include the costs for operations and maintenance of these facilities which includes: computer hardware and software; communications networks; security; and other essential capabilities necessary to develop and operate configurable, multiple experiment test bed environments. This document describes the support technology portion of funding for these activities.

PROJECT NUMBER: 3352
PROJECT TITLE: Modeling and Simulations
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0603872C RDT&E	64,180	73,173	72,984

PROJECT DESCRIPTION:
This project provides for the development/modification and validation of Modeling and Simulation (M&S) techniques and tools that are critical in assessing the projected, alternative, and demonstrated performance capabilities of Theater Missile Defense (TMD) and National Missile Defense (NMD) systems. These large and complex M&S tools require high performance vector and parallel processing supercomputers, scalar processors, and advanced graphic workstations for operation. Portions of this processing capability are housed at the Joint National Test Facility (JNTF) in Colorado Springs, CO, and the Advanced Research Center/Simulation Center (ARC/SC) in Huntsville, AL. These facilities operate in a distributed integrated simulation environment and host the modeling and simulation wargames that provide analysis, integration, demonstration, and performance verification of BMD systems. The JNTF and ARC/SC facilities and the Joint Missile Defense Network (JMDN), which links BMD Contractors, Services and other DoD government facilities, are utilized by all Services. Procedures are established to ensure efficient utilization of these facilities and to provide Verification, Validation, and Accreditation (VV&A) of the models, simulations, and systems portrayed. This cost effective approach reduces the need for more costly live fire missile test programs and establishes requirements for future technology needs. It promotes enhancements of M&S technologies that support: the acquisition process; the development and fielding of operational capabilities; and the development of common tools, methodologies, and protocols beneficial to data exchange, integration of various modeling and simulations, and software reusability of M&S applications.

This project funds the development, operation, and VV&A of the Extended Air Defense Test Bed (EADTB) and the Extended Air Defense Simulation (EADSIM) which support the analysis

required for TMD program acquisition and integration. The EADTB is a flexible distributed simulation tool that can determine the performance of existing and conceptual extended air and missile defense systems with the added complexity of theater missile defense threats. This is a multinode test bed that is comprised of high and medium fidelity models of sensors, environments, weapon systems, threats, and Battle Management Command, Control and Communication (BM/C^3) systems. The capabilities of the EADTB are being incrementally developed and accredited with the Services. EADSIM is a low to medium detail simulation system that operates on a standalone workstation. This simulation is used for architectural analysis of EAD systems and provides user interface for scenario preparation and model description.

M&S activities also funded by this project include: development, enhancement, and maintenance of the theater test beds and conduct of war games that provide the analysis, integration, demonstration, and performance verification for TMD systems. It ensures joint usage of simulation tool resources, supports allied and friendly international participation and cooperation in wargaming exercises. This project focuses M&S support in five primary areas: standardization, assessments, development/modification, computer architectures/networks, and program management for BMDO and Service M&S programs.

Funding for these facilities is distributed through Project 3352. Three Program Elements (PEs), (NMD,TMD, and Support Technology) provided funding. This cost sharing approach ensures cooperation, contributes to achieving synergy across the efforts, and minimizes duplication of modeling and simulation resources. The total funding profile remains flat on an annual basis, with adjustments for inflation. For example, the decrease in TMD funding for JNTF in FY97 is offset by a corresponding increase in NMD funding. These PEs include the costs for operations and maintenance of the JNTF and ARC/SC facilities, and the JMDN which includes: computer hardware and software, communications networks, security, and other essential capabilities necessary to develop and operate reconfigurable, and multiple experiment test bed environments. This document describes the TMD portion of funding for these activities.

PROJECT NUMBER: 3354
PROJECT TITLE: Targets Support
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	**FY98**	**FY99**
0603872C RDT&E	22,842	27,603	18,721

PROJECT DESCRIPIION:

This project provides core funding for targets and services needed to support the testing and evaluation of all Theater Missile Defense (TMD) programs, in particular THAAD, PATRIOT PAC-3, Navy Area TBMD and Navy Theater Wide TBMD, USMC Hawk, and the U.S. Air Force Air Borne Laser (ABL). This project is a segment of the BMDO Consolidated Targets Program (CTP). The CTP mission is to provide threat representative ballistic missile target system support to interceptor and sensor development and acquisition programs. Each target system is tailored and reconfigured to meet unique mission requirements for each test. This project funds the development and demonstration of target systems and Foreign Military Acquisition (FMA) targets to

support TMD test and evaluation. The TMD programs fund the actual acquisition of Theater targets development of this program. The Theater High Altitude Area Defense (THAAD) system, Patriot Advanced Capability-3 (PAC-3) system, Navy Area TBMD (Lower Tier) and Navy Theater Wide TBMD (Upper Tier) systems require target system support to accomplish their planned test and evaluation. The THAAD program intends to use the Hera target system with planned launches at White Sands, NM and from Wake Island into the Kwajalein Missile Range (KMR) impact area. Additionally, THAAD testing in the Pacific requires short range (200-600 km) and long range (1,000-2,900 km) target presentations which require development of a long range air launch target system. The PAC-3 program will use STORM and Hera targets launched from White Sands and Wake Island. The Navy will use the air launch target launched at Pacific Missile Range Facility (PMRF) (Barking Sands, Kauai, HI). This project is developing a short range (200-600 km) air drop ballistic target and a long range (1,000-2,900 km) winged air-launched target to satisfy the collective target requirements of THAAD and both Navy programs for multiple simultaneous engagements, multi-axis scenarios, and short-range and long-range threat target presentations. The project is also developing reentry vehicles to simulate the full range of threat targets.

PROJECT NUMBER: 3359
PROJECT TITLE: System Test & Evaluation
PROGRAM ELEMENT/FUNDING ($ in Thousands:

	FY97	FY98	FY99
0603872C RDT&E	42,792	40,307	26,444

PROJECT DESCRIPTION:

This project provides for BMDO planning, oversight, and coordination of integrated Test and Evaluation activities, as well as inter-Service Test and Evaluation efforts for assessment of the Family of Systems (FoS). Once the test plans are developed, test resource and target development and support is provided. (Test resources located in Project 3360 include test facilities, ranges and test instrumentation; target development and support is found in Project 3354). The program provides for support to the Major Defense Acquisition Program (MDAP) mandatory Live-Fire Test and Evaluation (LFT&E). This includes estimates of probability of kill of chemical/biological submunitions, creation of models to determine chemical/biological ground effects, confirmation of damage laws from low mass/high velocity intercepts, confirmation of damage laws from high velocity rods, development of generic lethality targets. Additionally, this project provides the following: independent assessments of the JTMD system; maturity evaluation of technology programs; multiple-fidelity models and simulation to support system development testing; and execution of independent technical reviews, system analyses and performance evaluations which contribute to new or enhanced capabilities; management of the development process, and the decision-making process related to the allocation of resources. The performance evaluation has as its primary goals the identification and understanding of system-level performance drivers and the mitigation of technical risk, and to provide timely answers to critical issues and questions required by decision authorities through an annual Consolidated Evaluation Report (CER).

PROJECT NUMBER: 3360
PROJECT TITLE: Test Resources
PROGRAM ELEMENT/FUNDING($ in Thousands):

	FY97	FY98	FY99
0603872C RDT&E	35,507	30,888	30,201

PROJECT DESCRIPTION:
This project provides for BMDO planning, oversight and coordination of integrated test and evaluation facilities. The project includes inter-element as well as inter-Service test and evaluation efforts, and provides infrastructure for common ground test facilities, ranges and instrumentation. Project 3360 funds the common TMD test infrastructure costs including BMDO use. Individual programs pay only the direct costs associated with their specific testing efforts.

The mission common ground test facilities include:

- Kinetic Kill Vehicle Hardware-in-the-Loop Simulator (KHILS) at Eglin AFB, FL
- Aero Optic Evaluation Center (AOEC) located at Calspan Corp, Buffalo, NY
- Hypervelocity Wind Tunnel Number 9 (Tunnel 9) at the Naval Surface Warfare Center, White Oak, MD
- National Hover Test Facility (NHTF) at Edwards AFB, CA
- Army Missile Optical Range (AMOR) at the U.S. Army Missile Command, Redstone Arsenal, AL
- Infrared and Blackbody Standards at the National Institute of Standards and Technology (NIST) in Gaithersburg, MD.
- Hypervelocity Ballistic Range G Light Gas Gun at the Arnold Engineering and Development Center (AEDC) in Tullahoma, TN
- Captive Carry Capability at the Nevada Test Site
- 7V and 10V Space Chambers at the Arnold Engineering Development Center, Tullahoma, TN
- Portable Optical Sensor Tester (POST) and the Characterization of Low Background Mosaics (CALM) at Rockwell International, Anaheim, CA
- Naval Research and Development (NRaD) facility IR Devices Branch located at the Naval Command, Control and Ocean Surveillance Center, San Diego, CA
- The Center for Research Support (CERES) at the Joint National Test Facility, Falcon AFB, CO

The mission common range facilities include national ranges such as:

- White Sands Missile Range (WSMR) located in Las Cruces, NM

- Kwajalein Missile Range (KMR) located in the South Pacific and the Wake Island Complex located in the North Pacific Ocean
- Pacific Missile Range Facility (PMRF) located at Kauai, HI
- Gulf Test Range (GTR) located at Eglin AFB, Fort Walton Beach, FL.

The range instrumentation special test equipment, data collection assets, and range instrumentation include:

- High Altitude Observatory (HALO) with the Infrared Imaging System (IRIS) sensor, based at Aeromet, Inc., Tulsa, OK
- Sea-Lite Beam Director (SLBD), based at White Sands Missile Range, Las Cruces, NM
- High Altitude Optical Imaging System (HAOIS), based at White Sands Missile Range, Las Cruces, NM.
- Mobile Range Safety System and Kwajalein Range Safety Control System Upgrades
- NP-3 Aircraft upgrade for remote area safety support.
- Miscellaneous improvements to BMDO infrastructures and support systems

These ground test, range and instrumentation assets provide valuable risk reduction and test implementation capability in support of the TMD test and evaluation. The ground test facilities provide a cost effective method of testing and evaluating applicable component, subsystem and system level technologies. The common range facilities provide a cost effective method of flight testing missile and target components applicable to the TMD program and FoS, BM/C^3 and interoperability testing. The range instrumentation provides a cost effective capability to collect target signature characteristics, phenomenology data, and target/interceptor diagnostics on flight tests. These facilities and capabilities support systems design, verification and validation of target realism, and the evaluation of test results.

PROJECT NAME: 4000
PROJECT TITLE: Operational Support
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	FY98	FY99
0603173C RDT&E	26,907	30,206	31,992

PROJECT DESCRIPTION:

This project provides support in three basic areas: personnel and related support costs; funding to meet cost fluctuations and contract terminations; and management overhead required for the Support Technology program.

Personnel and related support costs common to all Support Technology projects include support

of the Office of the Director, Ballistic Missile Defense Organization and his staff located within the Washington, DC area, as well as BMDO's Executing Agents within the U.S. Army Space & Strategic Defense Command, U.S. Army PEO Missile Defense, U.S. Navy PEO for Theater Defense, U.S. Air Force PEO office, and the National Test Facility. This project supports funding for overhead/indirect personnel costs, benefits, and infrastructure costs such as rents, utilities, supplies, etc.

The BMDO prioritizes funding within this project to meet operational, contractual, and statutory fiscal requirements for the Support Technology program. Operational requirements include reimbursable services acquired through the Defense Business Operating Fund (DBOF), such as accounting services provided by the Defense Finance and Accounting Service (DFAS). Contractual requirements include reserves for special termination costs on designated contracts and provisions for terminating other programs as required. BMDO has additional requirements to provide for foreign currency fluctuations on its limited number of foreign contracts. Finally, statutory requirements include funding for charges to canceled appropriations in accordance with Public Law 101-510.

Assistance required to support BMDO overhead management functions for the Support Technology program is contained in this project. This assistance ranges from operational contracts to fully support functions such as ADP operations, Access control offices, and graphics support, to supportive efforts required, as well as to supplement the BMDO government personnel. Typical efforts include cost estimating, security management, contracts management, strategic relations management and information management. These efforts include assessment of technical project design, development and testing, test planning, assessment of technology maturity and technology integration across BMDO projects; and support of design reviews and technology interface meetings. Program control tasks include assessment of schedule, cost, and performance, with attendant documentation of the many related programmatic issues. The requirement for this area is based on most economical and efficient utilization of contractors versus government personnel.

The Fiscal Year 1996 Defense Authorization Act eliminates the management program element effective with the Fiscal Year 1997 President's Budget submission. This overhead management and indirect program support funding has been realigned in accordance with Public Law 104-106.

PROJECT NAME: 4000
PROJECT TITLE: Operational Support
PROGRAM ELEMENT/FUNDING ($ in Thousands):

	FY97	**FY98**	**FY99**
0603872C RDT&E	82,876	87,516	84,809

PROJECT DESCRIPTION:
This project provides support in three basic areas: personnel and related support costs; funding to meet fluctuation costs and contract terminations; and assistance required to fund support service contracts for the Theater Missile Defense (TMD) program.

Personnel and related support costs common to all TMD projects include support of the Office of

the Director, Ballistic Missile Defense Organization and his staff located within the Washington, D.C. area, as well as BMDO's Executing Agents within the U.S. Army Space & Strategic Defense Command, U.S. Army PEO Missile Defense, U.S. Navy PEO for Theater Defense, U.S. Air Force PEO office, and the National Test Facility. This project supports funding for overhead/indirect personnel costs, benefits, and infrastructure costs such as rents, utilities, supplies, etc.

The BMDO prioritizes funding within this project to meet operational, contractual, and statutory fiscal requirements for the TMD program. Operational requirements include reimbursable services acquired through the Defense Business Operating Fund (DBOF), such as accounting services provided by the Defense Finance and Accounting Service (DFAS). Contractual requirements include reserves for special termination costs on designated contracts and provisions for terminating other programs as required. BMDO has additional requirements to provide for foreign currency fluctuations on its limited number of foreign contracts. Finally, statutory requirements include funding for charges to canceled appropriations in accordance with Public Law 101-510.

Assistance required to support BMDO overhead management functions for the TMD program is contained in this project. This assistance ranges from operational contracts to fully support functions such as ADP operations, automated tool, Access control offices, and graphics support, to supportive efforts required, as well as to supplement the BMDO government personnel. Typical efforts include cost estimating, security management, contracts management, strategic relations management and information management. These efforts include assessment of technical project design, development and testing, test planning, assessment of technology maturity and technology integration across BMDO projects; and support of design reviews and technology interface meetings. Program control tasks include assessment of schedule, cost, and performance, with attendant documentation of the many related programmatic issues. The requirement for this area is based on most economical and efficient utilization of contractors versus government personnel.

The Fiscal Year 1996 Defense Authorization Act eliminated the management program element effective with the Fiscal Year 1997 President's Budget submission. This overhead management and indirect program support funding has been realigned in accordance with Public Law 104-106.

Appendix C

Acronyms

Acronyms

AADC	Area Air Defense Commander
AAW	Anti-Air Warfare
AAWC	Anti-Air Warfare Commander
ABCCC	Airborne Battlefield Command and Control Center
ABL	Airborne Laser
ABM	Anti-Ballistic Missile
ABMC	Adaptive Battle Management Center
ACAT	Acquisition Category
ACCS	Airspace Command/Control System
ACDS	Advanced Combat Direction System
ACE	ARM Countermeasure Evaluator
ACE	Areas For Capability Enhancement
ACES	Arrow Continuation Experiments
ACS	AEGIS Combat System
ACS	Altitude Control System
ACTD	Advanced Concept Technology Demonstration
AD	Active Defense
ADCCS	Air Defense Command and Control System
ADCP	Air Defense Communications Platform
ADP	Arrow Deployability Project
ADP	Automated Data Processing
ADTOC	Air Defense Tactical Operations Center
AEDC	Arnold Engineering Development Center
AEGIS	Naval Shipboard Weapon System for TMD
AFB	Air Force Base
AGRE	Active Geophysical Rocket Experiment

AHWG	Ad Hoc Working Group
AIMST	Advanced Interceptor Materials and Systems Technology
AIT	Atmospheric Interceptor Technology
ALERT	Attack and Launch Early Reporting to Theater
ALI	AEGIS LEAP Interceptor
ALI	Alpha/LAMP Integration
AMG	Antenna Mast Group
AMOR	Army Missile Optical Range
AMSC	Advanced Missile Signature Center
AO	Attack Operations
AOA	Airborne Optical Adjunct
AOC	Air Operations Center
AOEC	Aero Optic Evaluation Center
ARC	Advanced Research Center
ARC/SC	Advanced Research Center/Simulation Center
ARFOR	Air Force Commander
ARM	Anti-Radiation Missile
AST	Advanced Sensor Technology
AST	Airborne Surveillance Testbed
ASTP	Advanced Sensor Technology Program
ATBM	Anti-Tactical Ballistic Missile
ATP	Acquisition, Tracking And Pointing
ATP/FC	Acquisition, Tracking, Pointing and Fire Control
ATSD (NCB)	Assistant to the Secretary of Defense for Nuclear, Chemical, and Biological Programs
AWACS	Airborne Warning and Control System
AWS	AEGIS Weapon System
AWS	Arrow Weapon System

BCP	Battery Command Post
BES	Budget Estimate Submission
BM/C^3	Battle Management/Command, Control, and Communications
BM/C^{3}I	Battle Management/Command, Control, Communications, and Intelligence
BM/C^{4}I	Battle Management/Command, Control, Communications, Computers, and Intelligence
BMD	Ballistic Missile Defense
BMDO	Ballistic Missile Defense Organization
BMEWS	Ballistic Missile Early Warning System
BPI	Boost Phase Intercept/Interceptor
BUR	Bottom-Up Review
C^2	Command and Control
C^2 Sim	Command and Control Simulation
C^3	Command, Control, and Communications
C^{3}I	Command, Control, Communications, and Intelligence
C^{4}I	Command, Control, Communications, Computers, and Intelligence
CALM	Characterization of Low Background Mosaics
CARD	Cost Analysis Requirements Document
CDI	Classification, Discrimination, and Identification
CDR	Critical Design Review
CDS	Congressional Descriptive Summaries
CEC	Cooperative Engagement Capability
CER	Consolidated Evaluation Report
CERES	Center for Research Support
CG	Cruiser (Guided Missile)
CHOP	Countermeasures Hands On Program
CI	Capability Increment
CIC	Combat Integration Capability

CINC	Commander-in-Chief
CJCS	Chairman of the Joint Chiefs of Staff
CM	Cruise Missile
CMI	Countermeasures Integration
CMIP	Countermeasure Integration Program
CNAD	Conference of National Armaments Directors
CoDR	Conceptual Design Review
COEA	Cost and Operational Effectiveness Analysis
CONOPS	Concept of Operations
CONUS	Continental United States
Corps SAM	Corps Surface to Air Missile
COTS	Commercial off the Shelf
CP	Counterproliferation
CPRC	Counterproliferation Review Committee
CRC	Control and Reporting Center
CRD	Capstone Requirements Document
CRP	Communications Relay Platform
CSED	Combat System Engineering Development
CTP	Consolidated Targets Program
CTR	Cooperative Threat Reduction Program
CTV	Control Test Vehicle
CVN	Aircraft Carrier (Nuclear Powered)
D/S	Down Select
DAB	Defense Acquisition Board
DACS	Divert and Attitude Control System
DARPA	Defense Advanced Research Projects Agency
DBM	Distributed Battle Management

DBOF	Defense Business Operating Fund
Dem/Val	Demonstration and Validation
DFAS	Defense Finance and Accounting Service
DGP	Defense Group on Proliferation
DIA	Defense Intelligence Agency
DISA	Defense Information Systems Agency
DITP	Discriminator Interceptor Technology Program
DoD	Department of Defense
DSP	Defense Support Program
DSTO	Defense Science Technology Organization
DT/OT	Demonstration Test/Operational Test
DT/OT	Developmental Testing/Operational Testing
DTR	Development Test Round
DUNDEE	Down Under Early Warning Experiment
E-2	Hawkeye Aircraft
E3	Electromagnetic Environmental Effects
EA	Environmental Assessment
EADTB	Extended Air Defense Test Bed
EAD/TMD	Extended Air Defense/Theater Air Defense
EADSIM	Extended Air Defense Simulation
EAGLE	Extended Airborne Global Launch Evaluator
ECC	Experiment Control Center
ECCM	Electronic Counter-Countermeasure
ECS	Engagement Control Station
EFEX	Endoatmospheric Aerothermal Flight Test Experiment
EIAP	Environmental Impact Analysis Process
EKV	Exoatmospheric Kill Vehicle

EMD	Engineering and Manufacturing Development
EOC	Element Operations Center
EPP	Electric Power Plant
ERD	Element Requirements Document
ERINT	Extended Range Intercept Technology
ETB	Electronic Test Bed
ETR	Engineering Test Round
EWR	Early Warning Radar
FBXR	Forward-Based X-band Radar
FC	Fire Control
FDP	Flight Demonstration Program
FDS	Flight Demonstration System
FEA	Front End Assessment
FM	Field Manual
FPA	Focal Plane Array
FOC	Full Operational Capability
FoS	Family of Systems
FPA	Focal Plane Array
FRP	Full Rate Production
FSU	Former Soviet Union
FUE	First Unit Equipped
FYDP	Future Years Defense Program
GBI	Ground Based Interceptor
GBR	Ground Based Radar
GBR-P	Ground Based Radar-Prototype
GCCS	Global Command and Control System
GEM	Guidance Enhancement Missile

GEO	Geosynchronous Earth Orbit
GOI	Government of Israel
GPALS	Global Protection Against Limited Strikes
GTACS	Ground Tactical Air Control System
GTR	Gulf Test Range
GTV	Guidance Test Vehicle
HABE	High Altitude Balloon Experiment
HALO	High Altitude Observatory
HAOIS	High Altitude Optical Imaging System
HARS	High Accuracy Reacquisition Sensor
HAWK	Homing All The Way Killer
HBCU/MI	Historically Black Colleges and Universities/Minority Institutions
HE	High Explosive
HELSTF	High Energy Laser System Test Facility
HEO	Highly Elliptical Orbit
HgCdTe	Mercury Cadmium Telluride
HIL	Human-In-The-Loop
HMMWV	High Mobility Multi Wheeled Vehicle
HWIL	Hardware-In-The-Loop
HWILT	Hardware-In-The-Loop Testing
I-HAWK	Improved HAWK
IAEA	International Atomic Energy Agency
IBIS	Israeli Boost Phase Interceptor System
IBS	Integrated Broadcast System
IDD	Interoperability Description Document
IDP	Integrated Deployment Plan
IER	Information Exchange Requirement

IFICS	In-flight Interceptor Communication System
IFOG	Interferometric Fiber Optic Gyro
IFT	Integrated Flight Test
IFTU	In-Flight Target Update
IGT	Integrated Ground Test
IIPT	Integration Integrated Product Team
IMoD	Israeli Ministry of Defense
IMU	Inertial Measurement Unit
InSb	Indium Antimonide
IOC	Initial Operational Capability
IPT	Integrated Product Team
IR	Infrared
IRIS	Infrared Imaging System
IRMA	Israeli Reference Missile Architecture
IR/RF	Infrared/Radio Frequency
IRST	Infrared Search and Track
ISA&I	Israeli System Architecture and Integration
IS&T	Innovative Science and Technology
IST	Integrated System Test
ISTC	Integrated System Test Capability
ITB	Israeli Test Bed
ITW/AA	Integrated Tactical Warning/Attack Assessment
JCS	Joint Chiefs of Staff
JCTN	Joint Composite Tracking Network
JDN	Joint Data Network
JEIO	Joint Interoperability Engineering Organization
JFACC	Joint Force Air Component Commander

JFC	Joint Forces Commander
JFLCC	Joint Forces Land Component Commander
JFMCC	Joint Forces Maritime Component Commander
JMCIS	Joint Maritime Command Information System
JMDN	Joint Missile Defense Network
JNTB	Joint National Test Bed
JNTF	Joint National Test Facility
JPN	Joint Planning Network
JRE	JTIDS Range Extension
JROC	Joint Requirements Oversight Council
JS List	Joint Staff List
JSTARS	Joint Surveillance and Target Attack Radar System
JTADS	Joint TADIL-A Distribution System
JTAGS	Joint Tactical Ground Station
JTAMD	Joint Theater Air and Missile Defense
JTAMDO	Joint Theater Air and Missile Defense Organization
JTIDS	Joint Tactical Information Distribution System
JTMD	Joint Theater Missile Defense
JWCA	Joint Warfare Capabilities Assessment
KE	Kinetic Energy
KHILS	Kinetic Kill Vehicle Hardware-In-The-Loop Simulator
KKV	Kinetic Kill Vehicle
KMR	Kwajalein Missile Range
KMRSS	Kwajalein Mobile Range Safety System
KV	Kill Vehicle
KW	Kinetic Warhead
LACM	Land Attack Cruise Missile

LADAR	Laser Detection And Ranging
LADS	Low Altitude Demonstration System
LAMP	Large Aperture Mirror Program
LCC	Launcher Control Center
LDS	Lexington Discrimination System
LEAP	Lightweight Exoatmospheric Projectile
LEO	Low Earth Orbit
LFT&E	Live Fire Test and Evaluation
LHA	Landing Helicopter Assualt Ship
LINK 11/16	Data Link Systems (JTDS / JTIDS)
LODE	Large Optics Demonstration Experiment
LOS	Large Optical Segment
LRIP	Low-Rate Initial Production
LSI	Lead System Integrator
LWIR	Long Wavelength Infrared
M&S	Materials and Structures
M&S	Modeling and Simulation
M/LWIR	Medium/Long Wavelength Infrared
MD	Missile Defense
MACCS	Marine Air Command and Control System
MDAP	Major Defense Acquisition Program
MAGTF	Marine Air Ground Task Force
MAOC	Modular Air Operations Center
MARFOR	Marine Forces Commander
MDA	Missile Defense Act
MDAP	Major Defense Acquisition Program
MDDC	Missile Defense Data Center

MDHAG	Missile Defense Ad Hoc Group
MDT	MSX Dedicated Target
MEADS	Medium Extended Air Defense System
MESAR	Multifunction Electronically Scanned Aperture Radar
MIDS	Multifunctionsl Information System
MILCON	Military Construction
MILSATCOM	Military Satellite Communications
MIRV	Multiple Independently-Targetable Reentry Vehicle
MM&D	Micro-Meteoroid and Debris
MMIC	Monolithic Microwave Integrated Circuit
MNS	Mission Need Statement
MoD	Ministry of Defense
MOR	Military Operational Requirement
MOP	Memorandum Of Policy
MOU	Memorandum Of Understanding
MQW	Multiple Quantum Well
M/S	Modeling and Simulation
MS II	Milestone II
MSE	Maintenance Support Equipment
MSLS	Multi-Service Launch System
MSTI	Miniature Sensor Technology Integration
MSX	Midcourse Space Experiment
MTCR	Missile Technology Control Regime
MTTV	Maneuvering Tactical Target Vehicle
MWIR	Mid-Wavelength Infrared
NAMEADSMA	NATO MEADS Management Agency
NAMEADSMO	NATO MEADS Design and Development, Production, and Logistics

	Management Organization
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NBC	Nuclear, Biological, and/or Chemical
NDI	Non-Developmental Item
NEPA	National Environmental Protection Act
NHTF	National Hover Test Facility
NII	National Information Infrastructure
NIST	National Institute of Standards and Technology
NMD	National Missile Defense
NMD-GBR-P	National Missile Defense-Ground Based Radar-Prototype
NORAD	North American Aerospace Defense Command
NP	Nonproliferation
NP-3	Navy Patrol Aircraft
NPT	Nuclear Nonproliferation Treaty
NRaD	Naval Research and Development
NRL/NAST	Naval Research Laboratory/Navy Air Systems Team
NSG	Nuclear Suppliers Group
NTW	Navy Theater Wide
OASD	Office of the Assistant Secretary of Defense
OCA	Offensive Counter-air Operations
OIPT	Overarching Integrated Product Team
OPEVAL	Operational Evaluation
ORD	Operational Requirements Document
OSC	Optical Signature Code
OSD	Office of the Secretary of Defense
OTA	Office of Technology Applications

P^3I	Pre-Planned Product Improvement
P&M	Producibility and Manufacturing
PA&E	Program Analysis and Evaluation
PAC	PATRIOT Advanced Capability
PAC-1	PATRIOT Advanced Capabiliy-1
PAC-2	PATRIOT Advanced Capability Level-2
PAC-3	PATRIOT Advanced Capability Level-3
PATRIOT	Phased Array Tracking to Intercept Of Target
PAVE PAWS	Position and Velocity Extraction, Phased Array Warning System
PBD	Program Budget Decision
PD	Passive Defense
PD/V	Project Definition/Validation
PDR	Preliminary Design Review
PD/RR	Program Definition/Risk Reduction
PE	Program Element
PEO	Program Executive Office
PFS	Pre-Feasibility Study
PHST	Packaging Handling Storage Transportation
PIPT	Program Integrated Product Team
PLANEX	Planning Exercise
PLS	Palletized Loading System
PLV	Payload Launch Vehicle
PM	Project Manager
PMRF	Pacific Missile Range Facility
POM	Program Objectives Memorandum
POP	Proof Of Principle
POST	Portable Optical Sensor Tester

PQT	Production Qualification Test
PRC	Peoples Republic of China
PtSi	Platinum Silicide
QRP	Quick Reaction Program
QRP	Quick Response Program
QWIP	Quantum Well Infrared Photometer
R&D	Research and Development
RAM	Random Access Memory
RAMOS	Russian-American Observation Satellites
RASA	Remote Area Safety Aircraft
RCS	Radar Cross Section
RDT&E	Research Development Test and Evaluation
RFP	Request For Proposal
RHETT	Russian Hall Effect Thruster Technology
RISC	Reduced Instruction Set Computer
R&M	Reliability and Maintainability
ROW	Rest-Of-World
RSO	Resident Space Object
RTD	Radar Technology Demonstrator
RV	Reentry Vehicle
SAAWC	Sector Anti-Air Warfare Coordinator
SACEUR	Supreme Allied Command, Europe
SACLANT	Supreme Allied Command, Atlantic
SALT	Strategic Arms Limitation Talks
SAM	Surface to Air Missile
SAMMES	Space Active Modular Materials Experiment System
SBIR	Small Business Innovation Research

SBIRS	Space Based Infrared System
SBL	Space Based Laser
SBLRD	Space Based Laser Readiness Demonstrator
SCARLET	Solar Concentrator Array with Linear Element
SCC	Standing Consultative Commission
SCORE	Scientific Cooperative Research Exchange
SDI	Strategic Defense Initiative
SDR	System Design Review
SE&I	System Engineering and Integration
SEO	Survivability Enhancement Options
SES	Seeker Experimental System
SGI	Silicon Graphics Incorporated
SI	System Integrator
SICPS	Standard Integrated Command Post Structure
SIGINT	Signals Intelligence
SIRTF	Space Infrared Telescope Facility
SIT	System Integration Test
SLBD	Sea Lite Beam Director
SM	Standard Missile
SM-2	Standard Missile-2
SM-3	Standard Missile-3
SMTS	Space and Missile Tracking System
SOI	Statement Of Intent
SPO	System Program Office
SPICE	Space Integrated Controls Equipment
SRBM	Short Range Ballistic Missile
SRD	System Requirements Document

SRMSC	Stanley R. Mickelson SAFEGUARD Complex
SRR	System Requirements Review
SSCARR	Sapphire Statistical Characterization and Risk Reduction
SSDA	Solid State Demonstration Array
SSGM	Synthetic Scene Generation Model
SSRT	Single Stage Rocket Technology
ST	System Threat
STA	System Threat Assessment
STANAG	Standardization Agreement (NATO)
STARS	Strategic Tactical Airborne Range System
STARS	Strategic Target System
START	Strategic Arms Reduction Treaty
STRV	Space Technology Research Vehicle
SWIL	Software-In-The-Loop
SWIR	Short Wavelength Infrared
SWORD	Stinger With Optimized Radar Distribution
TAOM	Tactical Air Operations Module
T&E	Test and Evaluation
T/R	Transmit/Receive
T4P	TIBS/TDDS/TACDAR Tactical Processor
TACC	Tactical Air Command Center (Marine Corps)
TACC	Tactical Air Control Center (Navy)
TACDAR	Tactical Detection and Reporting
TACS	Theater Air Control System
TAD	Theater Air Defense
TADIL	Tactical Data Information Link
TADIL-J	Tactical Data Information Link-J

TADIXS	Tactical Data Information Exchange System
TAMD	Theater Air and Missile Defense
TAOC	Tactical Air Operations Center
TAOM	Tactical Air Operations Module
TBIG	TMD BM/C^4I Integration Group
TBD	To Be Determined
TBM	Tactical Ballistic Missile
TBM	Theater Ballistic Missile
TBMCS	Theater Battle Management Core System
TBMD	Tactical Ballistic Missile Defense
TBMD	Theater Ballistic Missile Defense
TCMP	TMD Critical Measurements Program
TCTA	Time Critical Target Aid
TDDS	TRAP Data Dissemination System
TECHEVAL	Technical Evaluation
TEL	Transporter Erector Launcher
T&E	Test And Evaluation
TEMP	Test and Evaluation Master Plan
TEMS	THAAD Energy Management Steering
TES	Tactical Event System
TFTOC	Task Force Tactical Operations Center
THAAD	Theater High Altitude Area Defense
TIBS	Tactical Information Broadcast Service
TIWG	Test Integration Working Group (Army)
TMD	Theater Missile Defense
TMD-GBR	Theater Missile Defense - Ground Based Radar
TMDI	Theater Missile Defense Initiative

TMDSE	TMD System Exerciser
TOC	Tactical Operations Center
TOM	Target Object Map
TOPAZ	Thermionic Experiment Conversion Active Zone In Core
TPWG	Test Plan Working Groups (Air Force)
TRADOC	Training And Doctrine Command
TRAP	Tactical Related Applications Program
TRAP	Threat Risk Assessment Process
TRE	Tactical Receive Equipment
TSD	Tactical Surveillance Demonstration
TSDE	Tactical Surveillance Demonstration Enhancement
TSWG	Target Signature Working Group
U.K.	United Kingdom
UAV	Unmanned Aerial Vehicle
UAV/BPI	Unmanned Aerial Vehicle/Boost Phase Intercept
UEWR	Upgraded Early Warning Radar
UOES	User Operational Evaluation System
USACOM	United States Atlantic Command
USAF	United States Air Force
USAKA	United States Army Kwajalein Atoll
USCENTCOM	United States Central Command
USCINCSPACE	Commander-in-Chief, United States Space Command
USD(A&T)	Under Secretary of Defense (Acquisition & Technology)
USEUCOM	United States European Command
USFJ	United States Forces Japan
USFK	United States Forces Korea
USMC	United States Marine Corps

USPACOM	United States Pacific Command
USSPACECOM	United States Space Command
UV	Ultraviolet
VISS	Vibration Isolation Suppression System
VLWIR	Very Low Wavelength Infrared
VLS	Vertical Launch System
VV&A	Validation, Verification, and Accreditation
WALEX	Warfare Analysis Laboratory Exercise
WASS	Wide Area Surveillance Sensor
WMD	Weapons of Mass Destruction
WSMR	White Sands Missile Range
WTR	Western Test Range